THE MONTHLY

Review

MERRY CHRISTMAS TO ALL

DECEMBER 1946

Seasons Greetings

As we approach the close of another year, our thoughts cannot help but turn to those who have contributed so materially to our success . . . . our customers whom we always regard as our friends.

Many of these friendships have covered a long span of years. Others have ripened recently. Some friends we have been privileged to meet and to know personally.

May we express our deepest appreciation for their patronage and good will in the past and wishing all a

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A Happy New Year

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Greetings of the Season
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8 9 10 11 12 13 14
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THE MONTHLY

Review

VOLUME 33 • DECEMBER 1946 • NUMBER 12

Published Monthly at
5800 N. MERVINE STREET
PHILADELPHIA 41, PA.
AMERICAN ELECTROPLATERS' SOCIETY
EXECUTIVE OFFICE
P. O. Box 168
JENKINTOWN, PA.
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Entered as second class matter July 1, 1946, at the post office at Philadelphia, Pa., under Act of August 24, 1912.

Du Pont monovalent solution cuts plating time in half.

Here's what this process offers:

of the cyanide solutions is a typical characteristic

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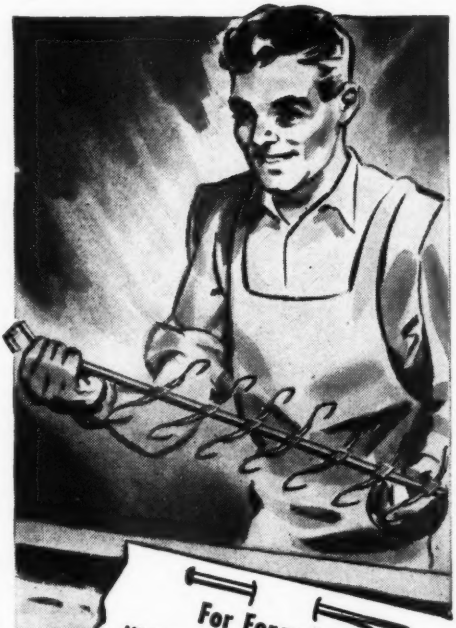

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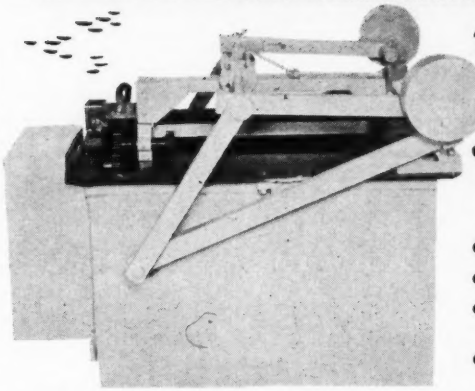

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- Can be used for a still plating tank
- Unloading trays are not necessary
- Cylinder and gears made of hard rubber

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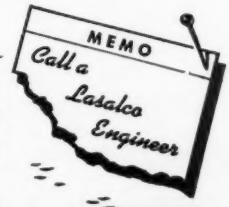

⅛ h.p. motor; 3 speeds—2, 4 or 12 r.p.m.; inside dimension of cylinder—10" dia. x 18"; capacity 8 qts., or 30 lbs., maximum; constructed with steel tank for cyanide solutions, or rubber lined tank for nickel solutions.

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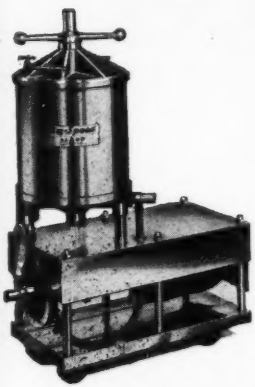

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COPPER PLATING for SELECTIVE CARBURIZING

By A. O. SAYERS

MICHIGAN CHROME & CHEMICAL COMPANY—DETROIT, MICHIGAN

Certain machine parts require extremely hard surfaces because of the wear to which they are subjected. Carburizing is one method of obtaining the surface hardness. The core of the part remains soft and thus it is possible to secure a wear resistant shell around an impact or shock resistant core.

On some parts it is necessary that the entire outer surface be hardened while on others selected soft areas are required. In most instances the soft areas should be entirely soft because hard spots on the soft areas may (1) interfere with final finishing operations and make tool wear excessive and (2) cause failure of the part in operation.

Electrodeposition of copper on the areas which are to remain soft is one means for prevention of local hardening. Copper combines low cost with speed and ease of application, is easily removed, does not melt and run off at carburizing temperatures, and has high resistance to the penetration of carburizing gases. All these advantages cannot be claimed for any other metal which accounts for the widespread use of copper as a masking medium in selective carburizing.

Having to do a large volume of copper plating for selective carburizing, we found it necessary to conduct a thorough investigation of the failures that occurred. It was found that failure of the copper plate to stop off was caused by several factors not necessarily directly related to the plate. These factors, together with those immediately concerned with copper plating, are the subject of this paper.

Base Metal Surface vs. Copper Thickness

One of the main factors influencing the masking qualities of a copper deposit is its thickness. Different degrees of roughness of the base metal surface require different minimum thicknesses of copper to prevent carburization. A minimum of 0.005 inch of copper will prevent penetration of carburizing gases to most surfaces satisfactorily. However, the greater portion of finishes requires only a fraction of 0.005 inch.

A means of measuring finish such as is shown in Figure 1 is valuable in predetermining the minimum thickness of copper necessary to prevent penetration to a given surface.

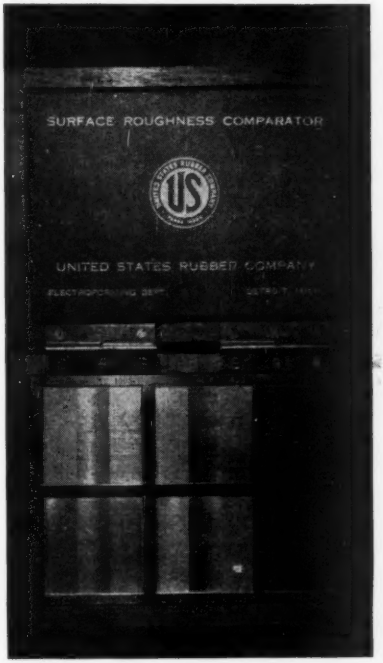

Fig. 1. Surface roughness comparator. Approx. ¼ full size

The 2-8 mean root square sections may require as little as 0.0004 inch of copper; the

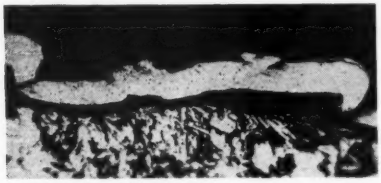

Fig. 2. Effect of a 150 microinch surface finish on plate thickness—on crest 0.00123 inch, in trough 0.00082 inch. Base metal etched with 3% nital, chrome flashed copper unetched. X125 reduced to X93

500S, 500M and 500T sections may need 0.002 to 0.003 inch of copper and the remaining sections 0.0012 to 0.0015 inch to prevent carburization of the underlying steel. (See Fig. 2.) Grit or sand blasted surfaces are usually well protected by a minimum of 0.0012 inch. Rough cast and forged surfaces may require as much as 0.005 inch, but in some instances even a deposit of this thickness may not prevent penetration.

The thicknesses of copper cited usually are satisfactory to prevent penetration through the plate. However, other factors enter the picture, many of which are described in the following paragraphs.

SLIVERS.—Magnetic parts often are covered with loose steel slivers. Slivers joined to the base metal may result from screw machine operations (Fig. 3). Both types

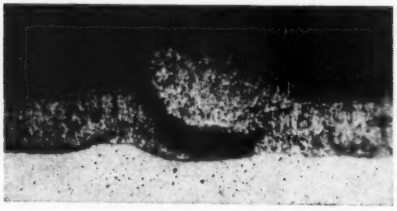

Fig. 3. Defective copper caused by steel sliver from screw machine operation. Base metal unetched, chrome flashed copper etched with ammonium hydroxide-hydrogen peroxide. X100

cause defective copper plate and penetration is the result.

IRREGULAR SURFACES.—Areas with burrs, rough surfaces and deep grooves may require two or three times the thickness of copper that is needed by smooth areas on the same piece, yet only sufficient copper for protection of the smooth surface may have been applied (Fig. 4). Difficulty in machining due to hard spots is then encountered after carburizing and hardening. Only the application of sufficient copper to protect the worst areas or, better still, the elimination of the imperfections prior to plating, can prevent this difficulty.

SAND PARTICLES.—One surface condition which might least be expected to cause penetration is the presence of sand or small stone particles imbedded in the base metal. These particles do not by themselves prevent car-

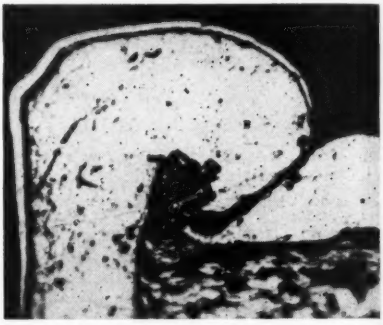

Fig. 4. Growth of copper plate around a burr with poor protection in corner. Base metal etched with 3% nital, chrome flashed copper unetched. X125 enlarged to X154

burization, yet hinder copper from being deposited on the underlying steel surface.

DECARBURIZED SURFACES.—Another rather interesting surface condition which may result in penetration is decarburization (Fig. 5). It has been found that the extreme outer layer of a badly decarburized surface may flake off. Forged surfaces may exhibit this characteristic. Any plate on the top of the layer will be of little value since it flakes off with it. Forged surfaces, in addition to being decarburized, usually are porous. The pores may cause holes in the copper plate through which penetration takes place. Removal of the forged surfaces may eliminate the difficulties. Failure to improve the condition by surface removal can usually be traced to the forging being porous throughout.

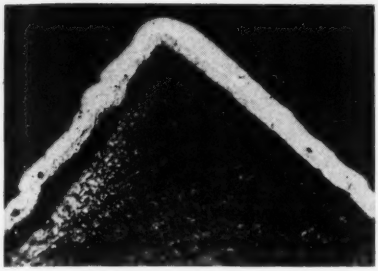

Fig. 5. Effect of removal of decarburized surface of forging by grinding before plating. Note penetration on unground left side and its absence on ground right side. Base metal etched with 3% nital, nickel plated copper unetched. X80 reduced to X63

CRACKS.—Cracks in the base metal may not be bridged over by copper of the usual thickness. The result is a hard area around the crack (Fig. 6). This may sound like a statement of a well known fact. However, surround the simple fact with a few pitfalls and there may be confusion. A piece may be pulled out of the furnace, hurriedly sectioned, polished, etched and examined for case depth. If a hard spot under the copper plate is noticed, the question arises as to how many more pieces have the same defect. On careful polishing and etching, a crack may be found to be the cause of the penetration. Cracked parts should be weeded out by the magnetic flux inspection to remove doubt.

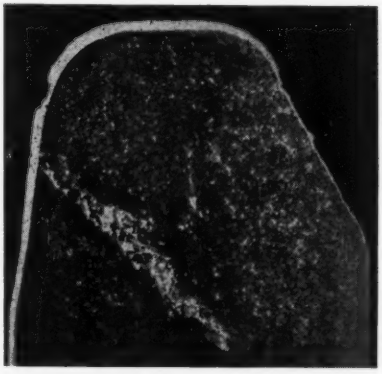

Fig. 6. Penetration along crack on left side which copper did not bridge. Unplated right side is hardened. Base metal etched with 3% nital, chrome flashed copper unetched. X30

PREPARATION OF METALLOGRAPHIC SPECIMEN IMPORTANT.—Careful preparation of metallographic sections is necessary in order to permit determination of the cause of hard spots. Staining around the edges has been interpreted to be caused by penetration, though in reality there was none. Holes or cracks in the base metal have been said to be bridged over, and countless other faulty conclusions have been drawn because of careless metallographic technique or poor understanding of the art of sectioning.

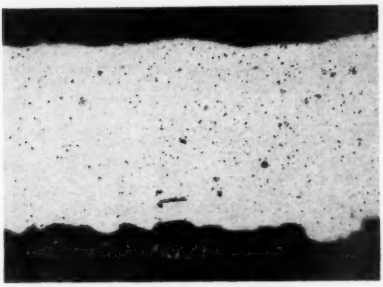

Fig. 7. Effect of incomplete removal of scale in sand blasting. Note poor adhesion to surface with light scale. Base metal etched with 3% nital, chrome flashed copper unetched. X522 enlarged to X570

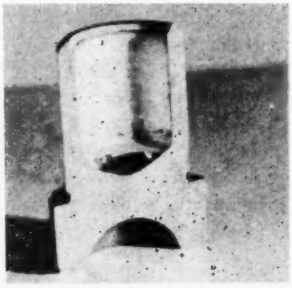

Fig. 7A. Cross-section of part with scale left in recess prior to plating. In drilling a small hole, not visible, copper lifted as shown. Full size

SCALE.—Perhaps the most common difficulty is scale on the metal surface. Plate will not adhere to scale. (See Figs, 7 and 7A). Parts which have been hear treated prior to plating should be examined very closely before plate is applied. Those with scale

should be rejected, unless there is a special setup for the removal of scale in the plating cycle. Where parts are freed from scale by a tumble blast, a definite time should be specified for a given number of pieces after first determining the minimum time necessary to remove all scale from an equal number of parts. An added word of precaution: parts which are to be grit or sand blasted should be free from oil or grease which tend to cushion the blow of the blasting particles and thus make removal of scale more difficult. We have plated parts which have been machined, heat treated, grit blasted and remachined, leaving machined and grit blasted areas on the same part prior to plating. The copper over the grit blasted areas has flaked off giving no protection while on the machined areas it has stuck tightly and no penetration took place. The scale layers on steel may be so thin that they are invisible to the naked eye, yet special techniques must be utilized by the plater to remove them since they may be unaffected by the ordinary cleaning cycle. Thicker plate over a scaly surface will not help in preventing penetration. Scale *must* be removed from a surface before copper will mask it.

A rather troublesome job which gave poor results due to scale will be described. (See Fig. 7A.) We barrel copper plated a load of approximately two thousand peices which had been normalized, then grit blasted before plating. When a hole was being drilled after plating, the copper lifted as the drill went through the metal. Thirty-two pieces out of the two thousand showed lifting. Earlier, some pieces had been found with carbon penetration around this particular hole which was in a deep recess. Lifted copper was the cause of penetration. Examination of a new lot before plating and also of the pieces on which the copper had lifted, showed heavy scale in the recess around the area where the hole was to be drilled. More complete grit blasting cleared up the difficulty. This is typical of grit or sand blasted surfaces which always require close inspection before plating in order that any degree of perfection be realized.

Plating

The difficulties already related pertain to operations prior to copper plating. There remain difficulties caused in the copper plating process proper.

Perhaps the first point which should be elucidated deals with the relative value of copper plate from different commercial paths. Although the copper structure may vary, there seems to be little diversity in resistance to carburizing gases, providing the baths are maintained within the recommended limits during operation. However, unless care is exercised in both solution upkeep and work processing, any solution, independent of type, will give poor results.

Poor Adhesion.—Lack of adhesion may not only be caused by scale but also by faulty or insufficient cleaning. The cleaner or the acid dip or both may be contaminated with foreign matter which deposits on the work as a smut; for example, copper in the pickle will deposit by immersion. Too short cleaning or pickling time or too weak cleaners or acid dips are other malefactors, all of which can be avoided by proper control of the operation.

The plating process must be closely watched also. Placing work in high speed copper baths without a preliminary strike will cause poor adhesion.

Laminated Plate.—Copper peeling from copper, i.e., when the piece is machined prior to carburization, has caused trouble. In still plating we have traced the difficulty to contaminated rinse water between the strike and the high speed bath. Chromium in the strike may have the same effect. The problem is more involved in barrel plating, but this is believed to take place: When a copper barrel solution is freshly prepared, it contains a minimum of impurities. When the plant with the new solution is operated, drag-in causes solid foreign matter, acid from the acid dip, and even cleaner to enter and build up in the solution. As the proportion of impurities to copper increases, more and more of the impurities plate out in a periodic fashion. (See Figs. 8 and 8A.) As a result, the copper is deposited in layers which have poor adhesion to each other. When the article is machined or heated in the carburizing furnace, the layers rupture and the result is penetration of gases.

Rough Copper.—Closely related to the last cause is that of rough copper. (See Fig. 9.) Both can be caused by impurities in the solution. However, copper peeling from

copper is not always accompanied by rough plate. Rough copper can be termed a cause

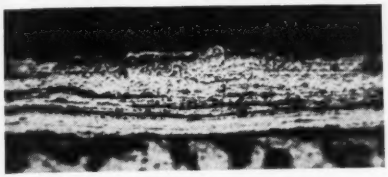

Fig. 8. Poorly adherent laminations of barrel copper plate. On area not shown, machining caused peeling in the dark areas. Base metal etched with 3% nital, chrome flashed copper etched with ammonium hydroxide-hydrogen peroxide. X250 enlarged to X274

of penetration because of its structure. In the first place, it is difficult to check the thickness of rough plate unless a cross-section is made. If a magnetic gage is used, only the thickness at the peaks is found. The layers in the valleys are of undetermined thickness and may be too thin for protection against carburizing gases. Also, the knolls break off easily in some instances, leaving a pit which may permit carbon penetration into the steel. For these reasons, it is usually advisable to strip work which shows excessive roughness, unless the roughness is due to a

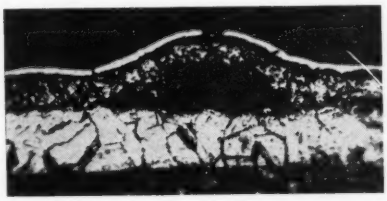

Fig. 8A. High temperature causes laminated barrel plate to blister. Base metal etched with 3% nital, chrome flashed copper etched with ammonium hydroxide-hydrogen peroxide. X200

rough base metal surface or to an abnormally heavy deposit.

Poor Rinising.—In some instances, the portion of the surface to be hardened is masked prior to plating with rubber or plastic plugs or sleeves to obviate the need for removal of copper by grinding. However, if cyanide copper solution is trapped between the mask and the steel article and then is smeared over the surrounding copper deposit when the mask is removed, the smeared area may fail in carburizing. This indicated the advisability of rinsing the plated objects both before and after removal of the masks.

Wire and Contact Marks.—It is important that the plater know which part of a piece is to remain soft, otherwise contact for plating may be made to such areas and no plate or insufficient plate for protection may result under the contact point. Sometimes this is necessary, but then one must usually move the contacts and plate further before

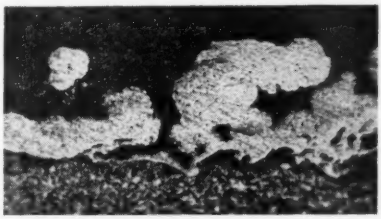

Fig. 9. Typical structure of a rough coating with thick plate on some areas and thin plate on others. Base metal etched with 3% nital, chrome flashed copper unetched. X140

removal of the part from the plating bath to insure protection.

Poor Contact and Inspection.—A certain number of parts in a load may get insufficient plate because of poor contact. For this reason it is advisable to check the contacts for each load of work while plating. Under no conditions should a load be passed without first checking some parts for thickness. Usually it is best to check the low current density area on parts which are liable to have received the least amount of plate. Then all other parts should have at least the minimum plate thickness.

Auxiliary Steps After Plating

After the copper has been applied to a piece and before it reaches the carburizing, there are usually many chances for it to be nicked. Nicks may cause carbon penetration as will careless machining or grinding. We have examined parts from which the copper

had been removed by machining or grinding from areas to be hardened and found that the grinding wheel or tool had deeply nicked or scraped the copper on the areas which were to remain soft. (See Figs. 10 and 10A.) This led to penetration. It sometimes happens that a blueprint is read wrong and the copper is machined or ground from the wrong areas. A similar situation exists when copper is incorrectly removed by selective stripping methods.

Should the piece slip in the adapter or arbor by which it is held during machining, the copper may be scraped where protection is needed. Again, the result is penetration.

Activated Sulfur Base Cutting Oil.—If a hundred identical pieces are plated and it is found that the carburizing gases do not penetrate 0.0012 inch minimum of copper, it is reasonable to assume that more such pieces will be protected by the same amount of plate. Let us follow such a job through the post-plating cycle. The copper is removed by grinding from the areas to be hardened. Following this the pieces are carburized. In checking the case depth, it is found that carbon has penetrated the copper even though it is adherent, smooth, and of sufficient thickness, and the surface was suitable for

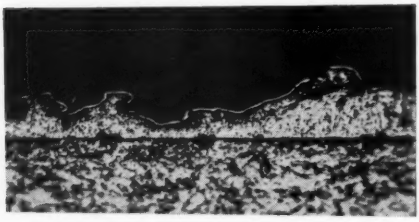

Fig. 10. Effect of a grinding wheel merely touching copper plate on left side. Note original thickness of copper on right side. Base metal etched with 3% nital, chrome flashed copper unetched. X100

plating. Since the case under the copper is not as deep as in those areas from which the copper had been removed, the copper gave some protection. In going back through the cycle, we find that an active sulfur-base cutting oil was used to lubricate the cutting tool when the copper was being removed. The cutting oil "oxidized" some of the remaining copper, leaving a layer of insufficient thickness to prevent penetration.

Heat Treating After Carburizing.—We have encountered loads of work on which the entire area intended to be soft had hardened. The case on these areas was not as deep as on the unprotected areas. A check on the heat treat cycle showed that the pieces

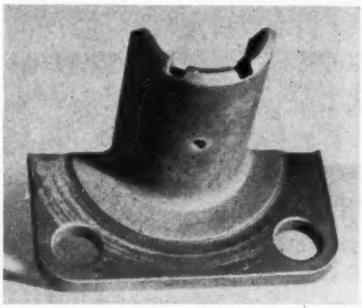

Fig. 10A. Carburized, hardened and grit blasted article with penetration on areas (especially left side of flange) from which copper was removed in a prior machining operation. Approx. one-half size

in question had been given an additional heat treatment at 1,475° F in a box carburizing furnace after the copper had been stripped. At the time it was thought that carburizing would not take place at such a low temperature. However, it did and the entire surface became carburized.

Too Much Copper.—It may be found that too much copper on certain areas prevent the pieces from fitting into the adapters which hold them during grinding or machining. Removal of the excess copper by filing or other means is difficult to accomplish without damaging the remaining copper sufficiently to permit penetration. Thus it may be necessary to change the dimensions of the part or of the adapter so that build-up of plate will not interfere with holding in subsequent machining.

Carburizing

There are two carburizing methods in general use at the present time: box carburizing and gas or homo carburizing. Provided the process chosen is operated under carefully controlled conditions, copper will resist penetration of carburizing gases. Both

(*Continued on Page 1310*)

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The Engineering Future

Of PLATED BEARINGS

By RALPH A. SCHAEFER

Director of Research—The Cleveland Graphite Bronze Company
Cleveland, Ohio

Physical Requirements

Until recently, the major use for the electrodeposition of metals and alloys was either for the protection of the base metal against corrosion or for decoration. Now the application of electrodeposition for the solution of specific engineering problems is receiving an increasing amount of attention. The outstanding success in the aircraft industry of the silver bearing with an overlay of lead and indium[1,2,3] is adequate proof of the importance of plating to future engine-bearing developments.

The exact physical properties which determine the value of a given material as a bearing are very difficult, if not impossible, to ascertain properly. There is inadequate correlation between the inherent physicochemical properties of the bearing materials and their mechanical behavior. The bearing industry's experience consists of a group of details interconnected with empirical data.

Nevertheless, it is felt that bearing materials should fulfill certain requirements, such as the following:

1. Have adequate mechanical strength to carry the load and should not work-harden severely under operating conditions so that the theoretical fatigue limit of the material can be approached.

2. Offer resistance to wear and not score the journal against which it is running.

3. Be able to deform plastically without fatigue or severe cold working when subjected to the slight misalignments encountered in the various mechanical devices which use bearings.

4. Be soft enough and of sufficient thickness to permit embedding of foreign particles from the oil stream under the specific conditions for which the bearing has been chosen.

5. Be chemically inert under operating conditions.

6. Have chemical affinity to mineral oils for efficient wetting.

In general, the commercially successful bearing materials will represent compromises since no single bearing material will fulfill all the requirements to a maximum degree. Some materials are satisfactory under one set of operating conditions and entirely unsatisfactory under another. Perhaps the most universally applicable bearing material is tin-base babbitt. Except for mechanical strength or fatigue resistance, it has unusually desirable properties at conventional bearing metal thicknesses for present-day requirements. In fact, it might be said that bearing research is an attempt to obtain tin-base babbitt properties in metals and alloys of higher fatigue resistance.

Engine experience has shown that the physical requirements on a bearing material are complex. The complexity is so great that one cannot hope to find the ideal materials in a single plated metal. The silver bearing, together with its overlay coatings of lead and indium, is in all probability the simplest constructed bearing from a chemical point of view. Here again, one discovers that a single metal is not entirely satisfactory. It is well to point out that while the number of metallic elements is limited, the number of alloys which can be produced is tremendous.

In some respects the mechanical engineers have made bearing research somewhat easier for the metallurgist and the chemists

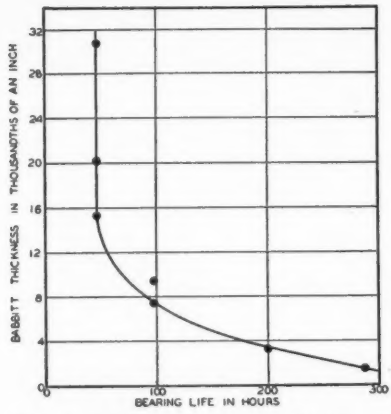

Fig. 1. Bearing life in fatigue testing at 2000 psi unit load vs. thickness of tin-base babbitt

in that they have proven that one of the best ways to improve the load carrying capacity of a bearing material is to diminish its thickness. The past decade of bearing development has shown that, within limits, the thinner the bearing metal, the better the bearing. This is well illustrated in Fig. 1 which is a plot of bearing life in hours versus tin-base babbitt thickness on fatigue testing in a modified Underwood machine at 2,000 psi loading[4].

However, one serious objection to extremely thin bearing metal layers is raised by the dirt problem. The dirt passing through along with the oil tends to cut grooves into the bearing to a depth which corresponds approximately to the diameter of the dirt particle. The exact size of these particles is a highly controversial subject. They probably approach an average diameter of 0.003 inch. It is a generally known fact that the cleaner the oil, the thinner can be the bearing liner, all other variables being constant. In some cases, the dirt problem can be so severe that soft bearing materials will become loaded with dirt and promote seizure.

Characteristics of Plated Materials

Engine performance has definitely proven that the adoption of relatively thin bearing metal layers represents one of the major steps forward in the development of the modern internal combustion engine. Such thin layers are a challenge to the electrochemist to develop materials and plating techniques which will make it possible to eliminate or at least reduce the need for expensive machining operations.

Electrodeposition has certain unique features which set it apart from other processes. Sometimes these characteristics work to the advantage of the engineer, at other times to his disadvantage.

1. Structure. By modification of the conditions of deposition for a given metal or alloy, outstanding changes in its structure and properties may be produced. A knowledge of the directions and magnitudes of such changes is desirable, not only to achieve any desired results, but also to avoid production of deposits with uncontrollable or undesirable properties.

2. Stress. Metals and alloys electrodeposit in a stressed condition. Ordinarily, the hardest plates are most stressed. Stress in the plate causes it either to expand or to contract and if adhesion or cohesion are inadequate, it will either buckle or crumble.

3. Surface. No matter how dense, coherent and smooth the base metal surface may be, the cohesion and the smoothness of the deposit generally decreases as the plating time

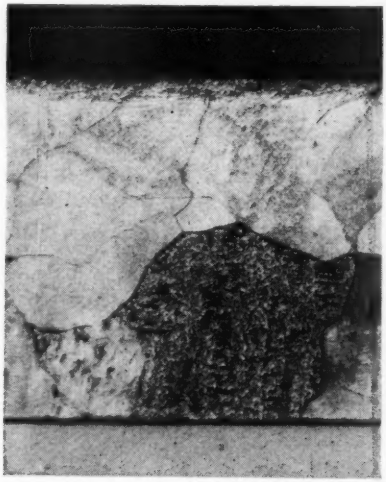

Fig. 2A. Cast silver, etched with ammonium hydroxide-hydrogen peroxide. X100

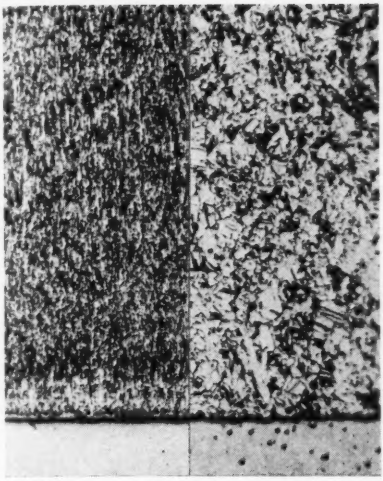

Fig. 2B. Electrodeposited silver etched with ammonium hydroxide-hydrogen peroxide. Left: as plated; right: annealed for 1 hour at 950° F. X100

is prolonged. This is perhaps the most serious limitation to electroplating extremely heavy deposits.

Metals which are co-deposited have been definitely established as true alloys. That the plated metals or alloys display extremely fine grain structure compared to cast alloys[6], is well illustrated by the typical photomicrographs of cast and plated bearing materials shown in Fig. 2A and 2B, 3, 4, 5A and 5B, 6A and 6B.

As a general rule, the physical properties of a plated alloy resemble those of the cast alloy, although there may be many isolated properties which may make them appear radically different, especially those which are directly affected by grain size and distribution of major and minor alloying constituents. It so happens that these are the properties which we are interested in exploiting for bearings. In general, heat treatment of alloy deposits causes increase in grain size and the alloy tends to exhibit the chracteristics predicted from the phase diagrams.

In plating (as in casting), certain types of alloys bond readily to the steel back while other types do it with considerable difficulty. In certain other cases, satisfactory adhesion between the steel back and the bearing metal has not been obtained to date. Good bond is essential for satisfactory bearing evaluation and performance, and it is also a very difficult property to ascertain.

Fig. 3A. Gravity cast and quenched lead-base babbitt containing 1% copper, 11% tin, balance lead, etched with picric acid. X1000

Comparisons Between Cast and Plated Bearing Materials

Mechanical testing of bearing materials

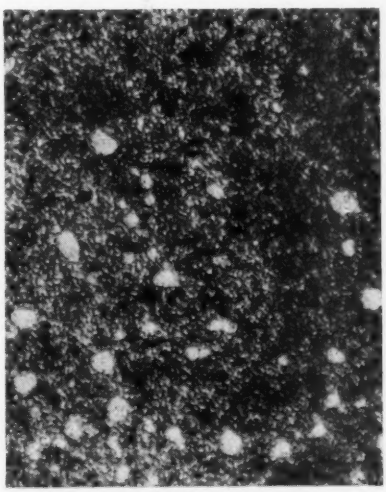

Fig. 3B. Electrodeposited lead-base babbitt containing 1.4% copper, 11.0% tin, balance lead, etched with picric acid. X1000

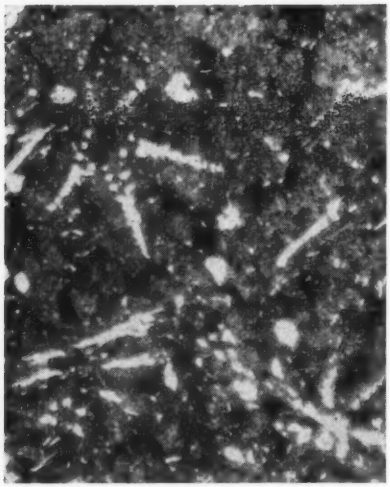

Fig. 4. Cast tin-base babbit of nominal composition: 3.25% copper, 7.5% antimony, balance tin, etched with 1% Nital. X1000

in the laboratory has been devoted largely to the evaluation of resistance to fatigue and wear. These two qualities plus the inherent physical properties of the materials themselves do, in the main, place the various experimental materials in their proper relationship to each other.

FATIGUE. The results shown in Tables I and II were obtained with a modified Underwood Bearing Testing Machine. The loads are calculated in pounds per square inch projected area. The mechanical set-up was maintained as near reproducible as possible.

TABLE I

Fatigue Data on 0.022 Inch Thick Silver Bearings Without Overlay

Testing to failure preceded by 10 hr break-in at low load, 21 hr at 3450 psi and 21 hr at 4570 psi

Manufacturing Process	Annealing	Average Time for Failure at 6040 psi hr
Casting	None	21
Plating	400° F—2 hr	13
Plating	900° F—1 hr	19
Plating	1200° F—1 hr	14

WEAR. The wear rates of various types of 0.001 inch thick plated overlays relative to lead-indium are shown in Table III. The data was obtained with the modified Underwood Bearing Testing Machine in which the bearings were subjected to 5500 psi loading at a surface speed of 1980 feet per minute and a temperature of 280° F in the presence of S.A.E. 10 neutral unhibited oil.

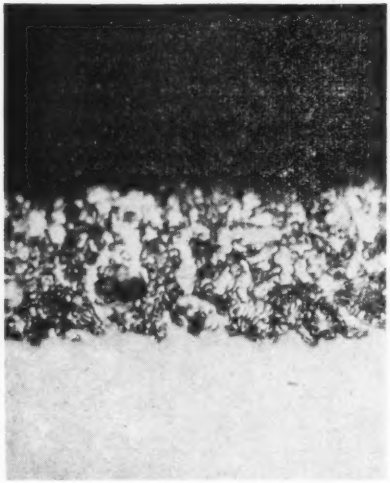

Fig. 5. Electrodeposited alloy containing 6% copper, balance tin as a 0.001 inch overlay on a silver-plated bearing (white). Etched with Nital. X1000

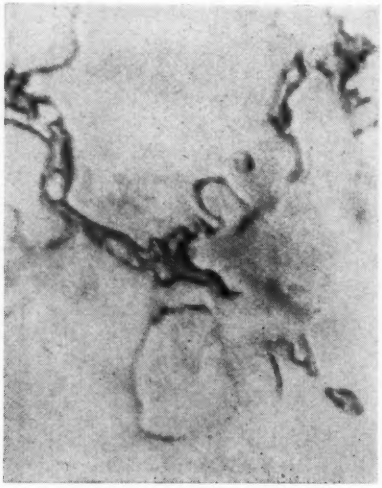

Fig. 6A. Alloy containing 4% lead, balance silver, cast on silver shell, etched. X1000

TABLE II

Fatigue Data on Bearing Materials

Testing to failure preceded by short break-in period at low load

Material Nominal Composition	Manufacturing Process	Thickness inch	Annealing	Test Load psi	Aver. Time for Failure hr
Silver	Plating	0.022	400° F—2 hr	7500	42
Silver-Lead 4 % Pb	Casting	0.022	None	7500	10
Silver-Lead 15 % Pb	Casting	0.022	None	7500	4
Silver-Lead 4 % Pb	Plating	0.022	500° F—2 hr	7500	95
Lead-Tin 10 % Sn	Plating	0.004	None	3600	23
Lead-Tin-Copper 10 % Sn, 1 % Cu	Plating	0.004	None	3600	77
Lead-Tin-Copper 10 % Sn, 3 % Cu	Plating	0.004	None	3600	113
Tin-Copper 6 % Cu	Plating	0.004	None	3600	26
Tin Base Babbitt 3 % Cu. 7 % Sb	Casting	0.004	None	3600	36

Conclusion

It is apparent from fatigue strength, wear resistance and engine performance data that plated metals and alloys usually perform similarly to equivalent cast bearing materials and that in certain cases, their performance is superior to that of the cast materials. Bearing research of the future will, undoubtedly, be conducted in both thermal and the electrochemical processes as well as in combinations of both. The fact that the thermal processes have had a considerably longer period of development than the alloy deposition processes may postpone full realization of electroplating developments for some time.

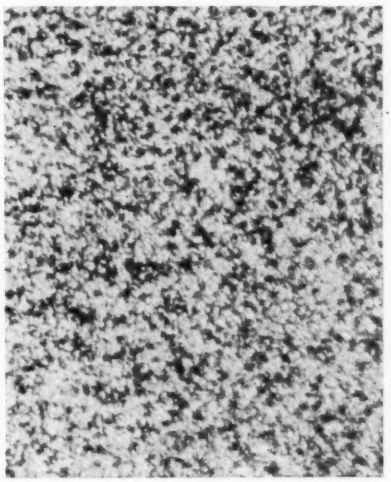

Fig. 6B. Electrodeposited alloy containing 4.8% lead, balance silver, annealed for 2 hours at 500° F and etched with ammonium hyroxide-hydrogen peroxide. X1000

TABLE III

Relative Wear Resistance of Overlays

Material Nominal Composition	Applied by	Relative Wear by weight loss
Pure Lead	Plating	9
Lead-Indium, 5 % In Diffused 340° F—2 hr	Plating	1
Lead-Tin, 10 % Sn	Plating	0.4–0.6
Lead-Tin-Copper, 10 % Sn, 1 % Cu	Plating	0.5
Lead-Tin-Copper, 10 % Sn, 3 % Cu	Plating	0.3–0.4
Tin-Copper, 6 % Cu	Plating	0.2
Tin-Copper, 2 % Cu	Plating	0.1–0.2
Tin Base Babbitt	Casting	0.05–0.1

In all probability the general pattern of future electroplating research in bearing materials will be to enhance either the metallurgical or the mechanical advantages which characterize the electrodeposited bearing materials known today. These advantages are:

1. The electroplated bearing alloys are produced cold and do not require the base metal to be subjected to undesirable heating and distortion.

2. The electroplated bearing alloys can be bonded to any of the common steels. Consequently the properties of the bearing materials and the steel back can be varied independently of each other.

(*Continued on Page 1315*)

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THE ADHESION OF ELECTRODEPOSITS

V. ANALYSIS AND APPRAISAL OF INFORMATION FROM LITERATURE AND PRIVATE COMMUNICATIONS

A. E. S. Research Project No. 3

Project Director: A. L. Ferguson

Chemistry Department, University of Michigan
Ann Arbor, Michigan

Outline of Paper

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Acknowledgment is due the Research Committee, Mr. E. C. Candee, American Brass Company, Chairman; the Research Directing Sub-Committee, Dr. R. M. Wick, Bethlehem Steel Corporation, and Dr. Louis Weisberg, Consulting Chemist, New York City, Chairman and Vice-Chairman respectively; and the Project Sub Committee, Dr. R. B. Saltonstall, The Udylite Corporation, Chairman; Mr. F. C. Mesle, Oneida Ltd., and Mr. E. Hahn, Ainsworth Manufacturing Company, for their contribution to this project.

INTRODUCTION

From the recorded literature it appears that an outstanding objective of many who have studied the adhesion problem has been to find a method which would give adhesion in pounds per square inch (psi). In the private communications, however, while there is some evidence of a desire for an absolute measure of degree of adhesion, greater emphasis is placed upon the need for a test which would be non-destructive and hence useful in production operations.

The industrial plater is especially anxious to have a test which will give him continuous assurance that his product will stand up in service. The type of test which will provide this assurance may differ depending upon the purpose for which the deposit has been applied. Most electrodeposited coatings are for corrosion protection or appearance, though there is growing interest in plating for salvaging and for bearings. The most essential quality of a plate used for bearings is adhesion, while adhesion of the same plate, when used for appearance, is of little importance.

The private communications indicate a pronounced tendency for each plater to develop one or more tests which will assure him that his product has the required adhesion to stand up under the particular usage for which it is designed. He is not particularly interested in knowing the numerical value of the adhesion and it is doubtful whether he would use such a test if it were available.

Only casual observation of the plated parts on the exterior of automobiles on the

roads today will convince one that something should be done to improve its quality. Recently the author had a personal experience along this line. A car was driven some distance with the emergency brake on slightly. When this was discovered, the hub disk on one wheel was too hot to touch. Within a few weeks the plate on this disk had largely peeled off, the other three were in good condition. This shows that a simple heat test would have indicated lack of sufficient adhesion. Even on the best cars, careful inspection after a few years' use shows numerous small blisters which later burst for one reason or another and initiate peeling. Tests have shown that many electrodeposits which have peeled comply amply with thickness specifications. The difficulty is not with thickness but with porosity or poor adhesion and usually with both.

There is a tendency to improve the situation by increasing the thickness. Greater thickness may eliminate some of the porosity, but will not improve the adhesion which is really the most important of the three factors.

There is need for an intensive study of the causes of porosity and poor adhesion. The chances are very good that remedies can be developed when the basic causes become known. The importance of a clean surface for good adhesion is not generally appreciated well enough.

The only way in which an electroplate can be held to the base metal is through some force or forces of attraction between the atoms at the interface of the electrodeposited metal and the base metal. This attractive force is commonly called adhesion. One may question to what this force of adhesion is due. The literature contains many names which supposedly indicate different kinds of forces such as adhesion, cohesion, adsorption, surface tension and crystallization. These are merely names for different manifestations of the same basic force that causes atoms to hold together in chemical compounds. It is a force between individual atoms and depends essentially upon the kind of atoms, the distance between the atoms, and the extent to which the forces have been satisfied by previous attachment to some other atom or atoms. In the case of a base metal upon which another metal is to be plated, the atoms in the interior of the metal have their forces completely satisfied by the surrounding atoms, but the layer of atoms in the very outermost surface are not completely satisfied. There are still available forces reaching out from the surface like hands or hooks to grab onto whatever comes along. Oxygen, sulfur, carbon dioxide, grease, oil and water vapor are the most common available materials to satisfy these remaining forces of the surface atoms. If they have been completely satisfied in this manner, there are no more left to hold the electrodeposited atoms.

The purpose of the cleaning operations prior to electroplating is to remove the materials which are satisfying the combining forces of the surface atoms of the base metal. The degree of adhesion of the electrodeposited metal depends upon the thoroughness with which the cleaning agents have done their work and upon the extent to which new materials have had an opportunity to satisfy these forces between the cleaning operation and the start of plating. If the cleaning is adequate and the time between cleaning and plating short, there should be no difficulty with adhesion.

ADHESION TESTS AND THEIR EVALUATION

This section contains a few summary remarks concerning most of the tests for adhesion in current use and the author's appraisal of these tests based largely upon the analysis of the published literature and of private communications from about 100 practical platers.

Bending and Twisting Tests

It was first recognized approximately forty years ago, by C. F. Burgess[1] that electrodeposits should be subjected to tests for adhesion. He was the first to propose or, at least, to record the bend test which is the test most generally used today. He also proposed a quantitative test and de-

veloped a device for measuring the adhesion in pounds per square inch.

Since that time, there have been extensive development and variations of the bend test and many variants have been put to use. They might be considered together as

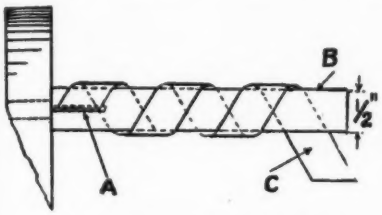

Fig. 1. Mandrel for twisting test (electrodeposits on aluminum)

deformation tests. Developments came slowly, however. It was not until twenty years later that the first faltering attempt was made to standardize the bend test.

The first serious attempt at standardization was made in 1929 by G. B. Brook and G. H. Stott[22] of England. Each part of the test was standardized, for instance, the length and width of the strip, the rate of bending, uniformity of bending movement, and diameter of the rod around which the piece was twisted. A diagrammatic representation is shown in Fig. 1. The test strip is eight inches long and ½ inch wide; the rod is ½ inch in diameter. One end of the strip is inserted in a slot in the rod and the other is held in pliers. The rod is rotated at a definite speed by a lathe.

Three years later, in 1932, A. W. Hothersall[37] described the bend test which, when combined with others, the present author considers to be among the best. (See Fig. 2.) When the deposit could be separated easily by a sharp, narrow chisel and then pulled away by the fingers, it was considered only SLIGHTLY ADHERENT. When some separation with the chisel was possible but only small pieces could be removed without cut-

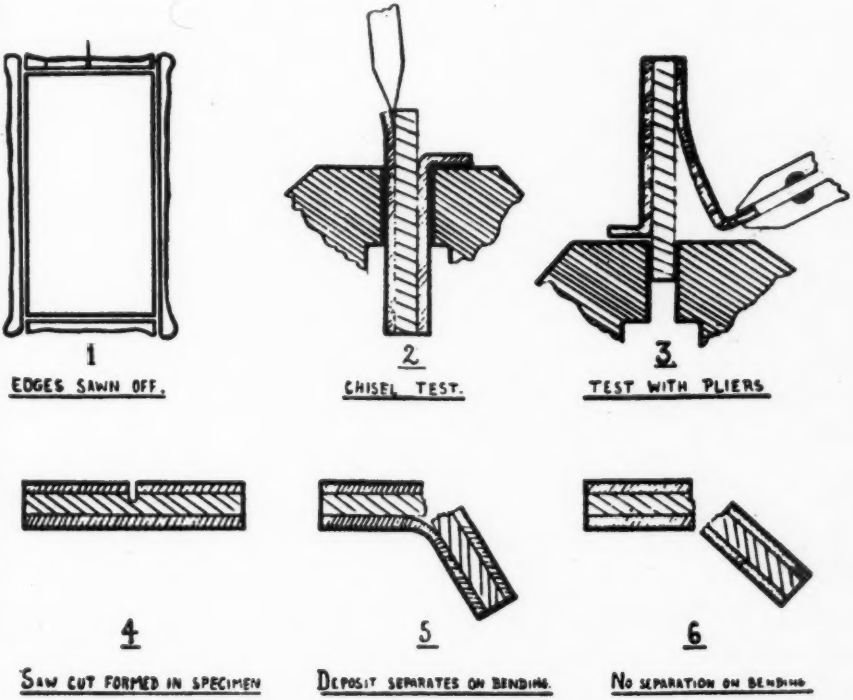

Fig. 2. Qualitative adhesion tests

ting through the deposit or into the base metal, the coating was considered STRONGLY ADHERENT. If a test such as illustrated in 4 and 5 (the hinge test) gave a separation of plate from base metal which could be detected only by means of a magnifying glass then the deposit was VERY STRONGLY ADHERENT. In case no separation whatever could be detected as in 6, the adhesion was perfect.

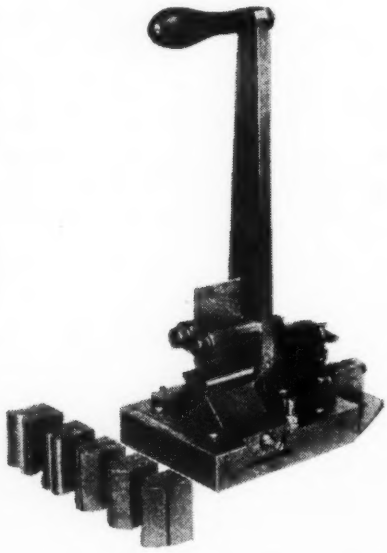

Fig. 3. Repeated-bend test machine for thin sheet metal

The present author has used this series of tests extensively. They are simple, very easily and rapidly performed, and show relative values to a fairly high degree when used by one person. They apply equally well to fairly thin and thick deposits. They are far from being quantitative, i. e., the results cannot be expressed in psi, but for a large number of plating operations this is no serious disadvantage. Of course, it is far from being ideal since it is destructive and cannot be used on a production line.

Another type of bend test which is used by many and in a variety of forms has much to recommend it. One arrangement described by R. L. Templin[70] in 1936 is shown in Fig. 3. Here again an effort is made at standardization. Samples of a definite width may be used, the angle may have any value from 90° to 180°. The rate of bending may be controlled, the radius of bending may be anything desired by the use of mandrels of various diameters; the radius of bending may be made to have a definite relation to the thickness of the base metal or deposit. The results may be expressed in terms of an arbitrary standard.

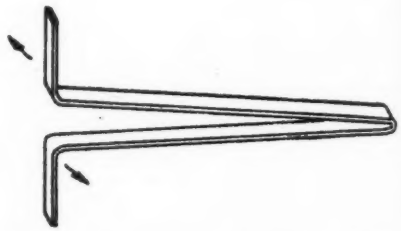

Fig. 4. Rocking or twist test specimen, bent into V shape, is twisted as shown by arrows, then in reverse direction; twisting is repeated until failure occurs

It should be pointed out that this type of test is not satisfactory for comparing the degrees of adhesion of deposits of different metals. The test works on the principle that it produces a shearing stress between the base metal and the deposit. If the deposit is highly ductile, the shearing force is much reduced because the plate flows and the base metal may even break without the plate loosening. However, an inspection of the fracture will usually provide some indication. A brittle deposit may crack, but even then the test may give worthwhile information about the adhesion. The fact that the deposit cracks does not mean that the adhesion is poor. In such cases, the fracture must be inspected to determine whether the deposit peeled or can be removed with a knife or chisel.

An interesting yet very severe test, which is a combination of the bend and twist test, is described by E. H. Lyons, Jr. [*Trans. Electrochem. Soc.*, *84*, 288, (1943)]. It is easily understood on inspection of Fig. 4.

For plated wire and certain plated strip

steel that must withstand extremely severe forming operations and customer usage, special and even more drastic bending and twisting tests have been devised. Among these is bending through 180° followed by hammering the bend flat and, if one wishes to be ultra-severe, opening it up and bending it back on itself in the opposite direction. Wire may be wound around a rod equal in diameter to its own and, at the same time, given a severe twist. An ultra-severe test is then to unwind the wire while at the same time it is being twisted in the opposite direction. This is continued until the wire has been wound around the rod in the opposite direction. A plated strip that stands the first test and a plated wire that stands the second will hold up under any type of fabrication or usage.

Burnishing, Buffing and Abrasion Tests

These tests are among the oldest extensively used tests in industrial plating. The literature does not contain much information concerning them, but they were mentioned in several private communications. They were described as far back as 1905 by C. F. Burgess.

Burnishing has been used almost universally in the silver-plating industry. It has not been looked upon as a test method, but the general feeling has been that a plate, which does not blister under the pressure of the steel burnishing tools used in the finishing operations, must have sufficient adhesion to meet commercial requirements.

Some types of burnishing or polishing or buffing, which are regular operations in many gold and nickel-plating plants, are considered adequate tests for adhesion.

A machine might be constructed which could give at least roughly quantitative information on adhesion. Certain factors could be standardized such as pressure, surface area of contact, speed of operation, area burnished, etc. The method would be limited to relatively thin deposits.

Impact or Hammering Tests

Numerous variants of this type of test are in daily use today. Usually a special design is developed to meet the requirements for a specific product. As a rule, the test is limited to heavy, ductile deposits or to thin as well as thick deposits of chromium or hard nickel.

The apparatus most generally used for making semi-quantitative impact tests are variants of the Parlin-du Pont impact tester[93]. In the test a known weight falls a predetermined distance and strikes a steel ball of definite diameter which rests on the

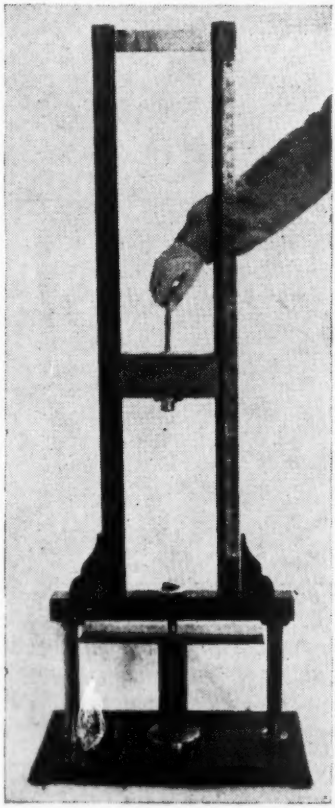

Fig. 5. Parlin-du Pont impact tester

panel being tested. The apparatus is shown in Fig. 5 and the lower part on a larger scale in Fig. 6.

Such tests when developed and used for special purposes are reported highly satisfactory; they are probably even more use-

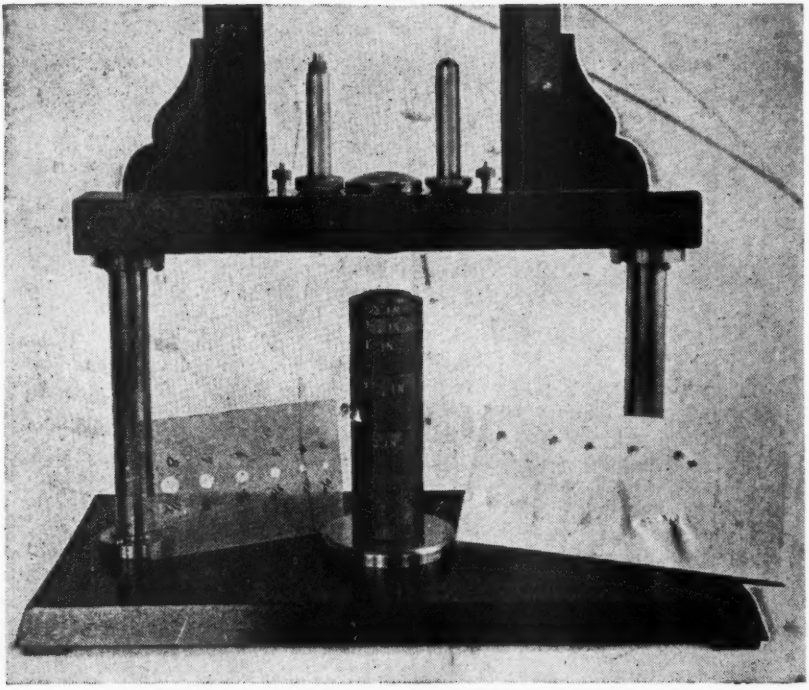

Fig. 6. Lower portion of Parlin-du Pont impact tester

ful than a quantitative test which would take longer time and require more delicate and expensive measuring devices.

The most recent impact tester was developed by A. W. Hothersall and C. J. Leadbeater[130] and is known as the B. N. F. Adhesion Tester. A small vibrating ball-ended hammer, which is actuated by a fluctuating magnetic field, bombards the surface. It is supposed to produce blisters somewhat in the manner of a burnishing tool and aroused considerable interest when it first appeared in the literature. However, it was soon discovered that the method would indicate only non-adherent or weakly adherent plate.

The Shot Impingement Test

Hothersall and Leadbeater describe another test, the "Shot Impingement Test", which operates according to the same basic principle. The complete assembly is shown in Fig. 7. Small steel shot are driven by regulated air pressure against the sample.

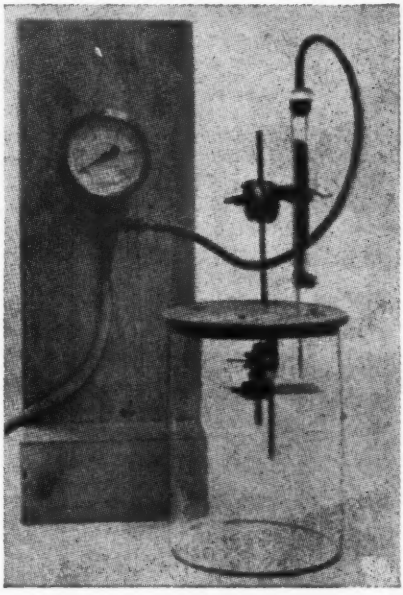

Fig. 7. Complete model of shot impingement test

After extensive experiments, the authors concluded that "it appears to be less suitable for general use than the B. N. F. Adhesion Tester".

In a private communication, Frank D. Hallworth describes an improved modification which he calls the "Shot Peen Test". It is suitable for production inspection and for testing coatings up to 0.025 inch thick. He makes this significant statement: "At this writing, it appears to be the most adaptable test available for checking silver adhesion". Such a statement should carry much weight in view of the fact that for four years during the war work was carried on in his laboratory on methods for testing adhesion of electrodeposits. However, it should be noted that he makes no other claims for the method than that it will find areas of complete lack of bond. Fig. 8 shows the results of an application of the test.

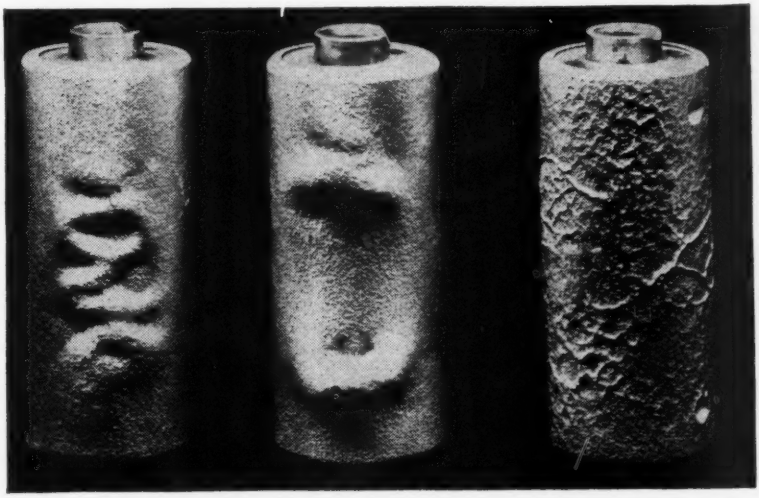

Fig. 8. Shot-peen tested articulated rod pins with defectively bonded silver plate

Hallworth experimented with many tests. His final conclusion is quoted here because as far as it goes it agrees with my own conclusions based upon the analysis of the published literature and many private communications. "The ideal bond-testing method, which instantly and non-destructively indicates adhesive strength, has not yet been devised. However, by the use of the methods outlined, silver-plated engine parts can be produced with assurance that those which pass the test will give satisfactory performance". A broader statement might be made to the effect that a special test could probably be developed for each plating operation which, if passed, would give assurance that the product would give satisfaction when used for the purpose for which it was intended.

Heating Tests

Heating is another very old test, having been mentioned by C. F. Burgess in 1905. Since then many heating tests have been developed. They have been used extensively for several years, especially to test electroplated aluminum. During the war heating was a required test for certain silver-plated bearings.

There are two distinctly different types of heating tests each based on a different principle. In one case, the heating causes the liberation of gas which had been absorbed in the base metal before or during plating, or evaporation of liquid absorbed at the interface or held in pockets in the

base metal. The pressure of the gases results in the formation of blisters. In the other case, the plated object is raised to some high temperature and then suddenly cooled. If there is a difference in the coefficients of expansion of the plate and base metal, a terrific strain is placed on the plate. Both of these tests are exceedingly severe under the specified conditions.

For several years there have been marked differences of opinion as to the influence of heating on the adhesion of an electrodeposit. The controversy arose largely as the result of an effort to develop a quantitative test whereby the adhesion could be measured in psi with a tensile machine. Such a test requires that a handle be soldered to the plate, and the soldering operation calls for a high temperature.

There is no doubt but that undisputed experimental evidence exists in support of both contentions—that heat increases the bond and that heat decreases the bond. A likely explanation is that the high temperature causes an interdiffusion of the two metals at the interface; this would be expected to produce better bond except when a weak alloy is formed whereby the apparent bond strength is decreased. Such cases are definitely known.

It is the opinion of the present author that both types of heating tests are highly valuable and drastic, provided they are not applied indiscriminately and only when the basic principles are known to be in effect.

"Black Light" or Fluorescent Test

This is one of the newer tests. The evidence now appears conclusive that at best it will detect only complete lack of adhesion around the edge of an article where the oil might penetrate between the plate and base metal. It is a better test for porosity, but it can reveal this only where the pore extends all the way to the outside of the plate.

Erichsen Cup Test and Variants

Generally three different names are attached to extrusion tests—the Erichsen Cup Test, the Olsen Ductility Test and the Romanoff Flanged Cap Test. In some cases a regular Brinell Machine has been used to force a steel ball into the test piece.

While most of the literature emanates from research laboratories, some plating plants are using these tests in specialized production.

The method appears to give highly uncertain results and has little to recommend it except in certain specialized applications. It is a better test for ductility than for adhesion.

The Scratch or Scratch-and-Knife Test

Among the early tests, this used to be one of those most generally employed. At the present time its application is very limited. This is due to two developments: a general improvement in adhesion and a rather general increase in thickness and quality of deposit. A variant is still relied upon by some bearing manufacturers to test the adhesion of thick deposits. One set of parallel grooves are machined through the plate to the base metal, the distance between them depending upon the thickness of the lining; then another set is machined at right angles to the first. A blunt chisel is placed against the rectangular sections thus formed and hit a sharp blow with a hammer. This is far from being a quantitative measure of the degree of adhesion However, it is simple, easy, rapid and thoroughly satisfactory for the particular purpose since, if the small rectangular sections cannot be removed in this test, the producer is certain the adhesion is satisfactory, no matter what the psi strength may be.

The Chisel Test

The test just mentioned might be considered a variant of the chisel test. This test is of comparatively recent development and parallels the development of thick deposits. There are numerous variants, some of which are exceedingly drastic and considered the most severe tests for heavy deposits thus far developed. Some companies have rather rigid specifications for both test equipment and test procedure. From highly favorable reports in private communications, and from personal experience

it may be stated that this is an exceedingly effective test. Its use carries with it a feeling of assurance that a plate which stands the test is certain to give satisfaction in the particular application for which it is intended.

The Grinding Wheel Test

There are several variants of this test but the only one worthy of special mention is that in which the plated article is held against a rough emery wheel so that the wheel cuts from the base metal to the deposit. This is a pet shop-method used by many of the best known men in the industry. It appears that each has his own special idea about just how the test should be carried out. All agree, however, that if properly made it is highly effective. The ductility of the deposit is a rather important factor—for extremely brittle or ductile plates the results are questionable.

The "Can Opener" Test

This is a relatively new method developed by F. C. Mesle[96]. The test piece is so processed that the deposit can be peeled from the top to make a handle to which is attached a special tool. This tool functions in much the same manner as the one for opening a sardine can, hence the name. The test becomes somewhat quantitative when some device is used to measure the load required to peel or break the deposit. If the design of the strip and the procedures are standardized and the test is carried out by an experienced operator, a fairly good comparison can be made for the adhesion of various samples. There are several factors of uncertainty, however, which make it questionable whether the method is capable of being developed to measure the bond strength quantitatively in psi.

The Jacquet Test

This might be considered as a more scientific development of the can-opener test and represents an attempt to devise a method which will give a measure of bond strength in psi. The principle involved is to deposit a thick plate over the one to be tested. The second plate is so processed that one end does not adhere and may be lifted to serve as a handle. This handle is then attached to some mechanism which pulls the under coating from the base metal. The force required is expressed in some selected units. Jacquet[62] infers the method gives psi.

The method was studied at the Bureau of Standards where some very interesting variations were developed largely in the method for attaching the heavy top coating and the choice of testing machine for measuring the force required to detach the under-plate. It is interesting to note that the results are expressed in force per unit

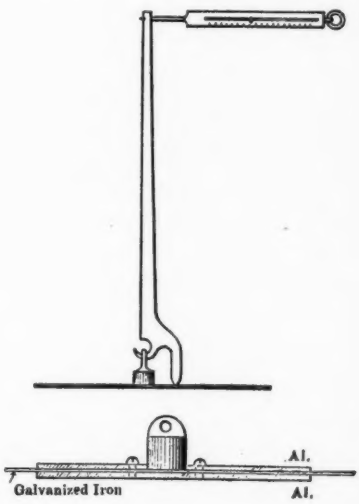

Fig. 9. Burgess' adhesion tester. Top: test in progress. Bottom: method of soldering

width of peeled strip rather than per unit *area*.

It is evident the method is very time-consuming and requires expensive equipment and rather precise manipulation. Even after all measurements have been made their interpretation is highly questionable.

The Ollard Test and Variants

Attempts to make quantitative measurements of the adhesion of electrodeposits go back to F. C. Burgess[1] in 1905. The equipment used is represented diagramatically in Fig. 9. A copper plug one-half inch in

diameter was soldered to the plate to be tested. To this was attached a lever arrangement, and a spring balance was used to measure the force necessary to remove the deposit from the iron base metal. A special arrangement was used to provide a measurable area of plate to be tested. It was appreciated by Dr. Burgess that the heat required for the soldering operation might alter the adhesion of the plate. He believed that the adhesion would be decreased.

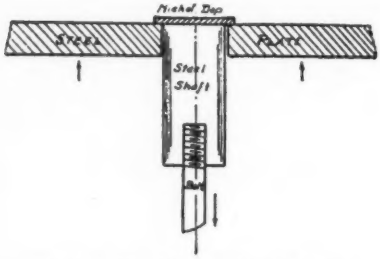

Fig. 10. Ollard's adhesion test, first method

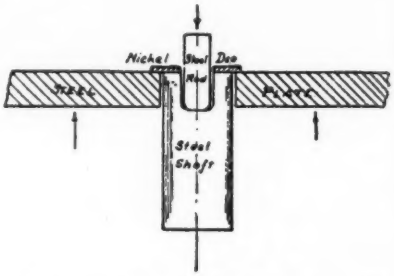

Fig. 11. Ollard's adhesion test, second method

No other quantitative test worthy of the name was developed until 1925 when Ollard submitted the method which goes by his name. The principle involved is simple

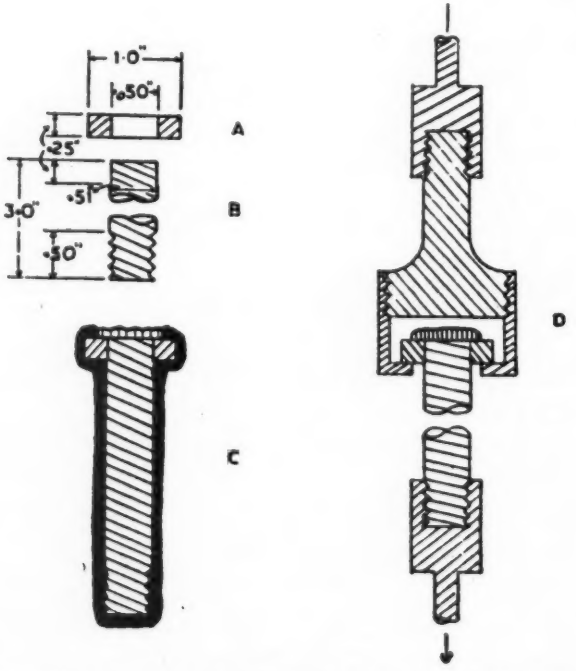

Fig. 12. Ollard's adhesion test as modified by Hothersall and Leadbeater. A bush, B rod, C stopped-off specimen after deposition, D specimen assembled in adaptor for test

and is indicated in the diagrams of Figs. 10 and 11. The plate to be tested is deposited on the end of a steel rod. In the first variant, the plate and steel rod were machined to leave an overhang of plate and the plate was pulled off as illustrated in Fig. 10. In the second variant, a hole is drilled through the plate and into the rod. The rod is placed in a hole in a steel plate and pushed off by a tensile machine as illustrated in Fig. 11. The area of the ring of interface between the deposit and the steel shaft is measured and thus the strength of the bond may be expressed in psi.

In 1938 Hothersall and Leadbeater[83] published a modification of the Ollard method. The diagrams in Fig. 12 illus-

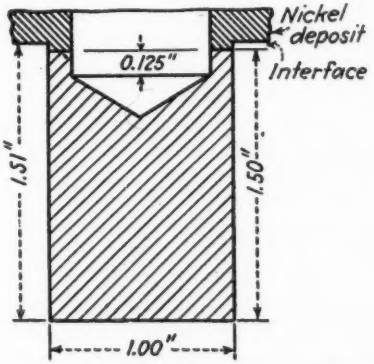

Fig. 13. Finished dimensions of Ollard's test specimens as modified by Roehl

trate the principles. A steel rod 0.5 inch in diameter was fitted with a steel bush one inch in diameter, the end of the bush being flush with the end of the rod. The material to be tested was plated over both. The test piece was then placed in a tensile machine as shown.

Another variation was described by E. J. Roehl[107] in 1940. This is illustrated in the diagram of Fig. 13. The principal difference between this and the original Ollard method is the machining of the lower part of the plate, indicated in the diagram as "interface". This assures that no plate extends over the top surface of the rod down on to the side.

More recently the Engineering Department of the Chrysler Corporation has refined the method to an even greater degree. It is referred to as the micro-adhesion method. This method has several points of improvement over the standard Ollard Method. It employs much smaller specimens and can be used where the deposit is on a curved surface, it is relatively fast and can be used on somewhat thinner deposits. The area under test is determined by using a micrometer to measure the outside diameter and a filar micrometer attached to a microscope to measure the wall thickness. The estimated accuracy is plus or minus 3.5 per cent.

Such quantitative methods as the Ollard test and its variations have no practical value outside of research laboratories and the extent of their real value even there is open to question. Even in the Chrysler version the pull or push on the plate to remove it cannot be considered to be at all times perpendicular to and equally distributed over the whole area used to calculate the bond strength in psi.

The Supersonic Test

The method most recently suggested for measurement of adhesion makes use of high frequency sound waves. Both the principle and application are fairly simple. A beam of high frequency sound waves of the order of 5,000,000 cycles per second is sent out by a vibrating quartz crystal. If this beam falls upon a plated object, some of the sound will pass through it and emerge on the other side where it can be picked up by a second quartz crystal. However, if there is no bond over any portion of the area struck by the beam, the discontinuity of elasticity will cause the sound to be almost completely reflected and none will be transmitted.

Dr. F. A. Firestone, a pioneer in the field of supersonics, expressed to me, in a private interview, the belief that the method would show a complete lack of bond but probably could not be used to measure degrees of adhesion.

Mr. Julian R. Frederick, also expressed himself as follows: "From the limited work

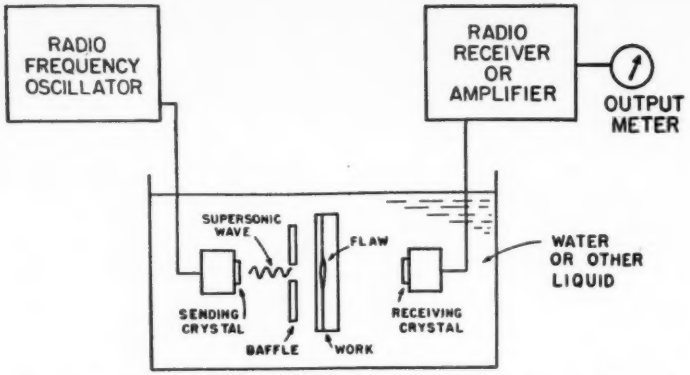

Fig. 14. Arrangement of apparatus to test bond by means of beam of supersonic waves

done, it was concluded that the method would readily detect absence of bond, but as to whether or not the strength of the bond could be measured, more investigation would be necessary." A diagrammatic sketch of the equipment used is shown in Fig. 14.

The first device used by Pratt and Whitney Aircraft for silver bond inspection was the supersonic reflectroscope invented by Firestone. The method is somewhat different from the one mentioned above. A quartz crystal radiates supersonic vibrations into the plate as before, but in this ease the reflected rays are studied rather than the transmitted rays. If the silver is slightly separated from the steel back, the pulse is either reflected or dispersed at the gap. By observing the amplitude and shape of the pattern on a cathode ray screen as the crystal is passed over the plated surface to be inspected, the operator differentiates between areas of good and bad bond. The photographs in Fig. 15 illustrate the difference in patterns given by good bond (left) and bad bond (right).

This method was used for two years in routine inspection by Pratt and Whitney Aircraft, but was then superseded by later methods. During this period several inherent difficulties were discovered which led to misinformation concerning the quality of the bond. Most important was that unless a true gap existed between the plate

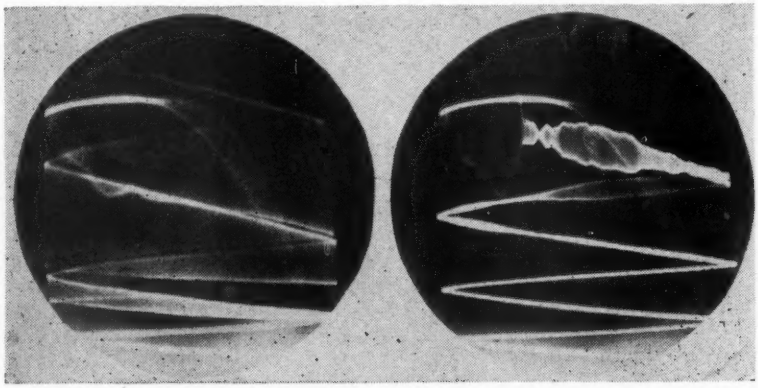

Fig. 15. Defective Double Wasp front counterbalance bearings after whirl testing at 40,000 rpm

and base metal, lack of bond could not be detected. Besides, the reflectroscope is an exceedingly complex device requiring a trained technician to operate it and to interpret the results.

Tests with Adhesives

There are other tests mentioned in the literature, some of which have been developed for special purposes and are being used very effectively. The one to be considered here is similar in principle to that first described by C. F. Burgess in 1905 in which a handle was soldered to the plate and the force required to pull the plate from the base metal determined. As pointed out earlier in this paper, the method was largely abandoned because the temperature reached during the soldering operation might alter the adhesion.

From that time to the present, however, methods involving the same basic principle have been used and are now being used by many practical platers. Various kinds of adhesives on strong tape as a handle are employed. The continued use of methods of this type probably results from the powerful desire of practical platers for a simple, quick and non-destructive test. One prominent plater applies scotch tape. Another uses a special brand of cement and believes it possible through an intensive study to develop adhesive joints which will permit direct tensile strength measurements of adhesion. Another very prominent plater states: "The adhesive test (used by him) consists in covering a plated surface with an adhesive tape, allowing it to stand for 24 to 48 hours, and pulling it off. Poor adhesion can be detected by this method. It is our thought that with bonding material of high strength, actual measurements can be made of the strength of a plated metal bond." Another very well-known plater offered the following suggestions: "Recently developed adhesives, which are said to give metal-to-metal bonds of great strength, might form the basis for a quantitative test which could be applied to simple shapes. After bonding suitable fixtures to the deposits and the base metal, the force required to separate them could be determined in a tensile testing machine . . . Whether the bond provided by the newer adhesives has sufficient strength remains to be determined."

Experimental Work with Adhesives

In view of such statements from outstanding representatives of the plating industry and the extensive developments carried out during the war in the preparation and use of adhesives, the Project Committee and the Research Directing Sub-Committee decided that at least some preliminary experimentation should be undertaken to determine the possibilities.

Several manufacturers of cements were contacted and their opinions on the matter were obtained. Hardly any special work had been done on this application, but interest was expressed in all instances and some made encouraging statements.

Samples of the following five most promising cements were obtained and some tests made on each:

(1) Metlbond Type M3c. (National Research and Manufacturing Company, 2330 Cleveland, National City, Calif.)

(2) Durite S-3024V Cement. (Durite Plastics, Inc., Frankford Station P. O., Philadelphia, Pa.)

(3) Bakelite XJ, 16320. (Bakelite Corporation, Bloomfield, N. J.)

(4) Pliobond (Manufactured by the Goodyear Tire and Rubber Company, and supplied by United States Plywood Corporation, Industrial Adhesives Division, 25 W. 44th Street, New York 18, N. Y.)

(5) Cycle Weld, C-3-Brush Type. (Chrysler Corporation, 8021 Conant Road, Detroit, Mich.)

There are two basic requirements on a cement which is to be used for measuring the adhesion of electrodeposited plate. One is that the cement must adhere to the plate and to the rod used as a handle with a force greater than the bond strength. The other is that the tensile strength of the cement must be greater than the bond strength. For these reasons, the experiments were directed toward a determination of these two factors for the various cements.

In the earlier experiments, known areas of two strips of steel were cemented together and the shearing force measured in a tensile machine. Later it was considered advisable to apply the force perpendicularly to the cemented faces. To do this latter, cylinders were machined flat on one end, and the other end was threaded to fit attachments on the tensile machine. The flat ends were cemented together with the material under test. Fig. 16 is a photograph of the assembly. Both brass and steel cylinders were used.

In the early work with steel strips adhesion was a major problem. In successive efforts to improve the adhesion, increasing precautions were taken to obtain a really clean surface. Ultimately the procedure was to degrease in hot liquid trichlorethylene, suspend in trichlorethylene vapor, clean cathodically, and finally polish electrolytically. Each added step gave better adhesion, but in no case was there definite assurance that the adhesion would be complete over the whole sample.

Later, when cylinders were used, the difficulty with cement adhesion was not so serious. Before each test a new surface was machined on the face of the cylinder, which the only cleansing was to place the parts in a specially constructed vapor degreasing chamber where they were continuously washed by freshly condensed liquid.

An even more serious difficulty was the fomation of bubbles in the final test piece as shown after pulling. Much time was spent in an attempt to discover some means for completely eliminating the bubbles, but that objective was never attained without a serious decline in the tensile properties of the cement. The best result was obtained when the most suitable diluent was selected and the pre-curing was carried out under such temperature and solvent vapor pressure conditions that the drying process was exceedingly slow. The time required was about 24 hours. By this treatment it was possible to obtain dried cylinders completely free from bubbles. However, when the cylinders prepared according to this procedure were placed together and given the final treatment under pressure and at the higher temperature required for final curing, in every case the fractured surface observed after pulling always showed bubble formation.

After the most satisfactory conditions for adhesion and for minimum bubble formation had been established, attention was given to the curing temperature and curing time. While the correct temperature is the determining factor, the length of time is also important. Although the number of samples prepared in the preliminary work on the five different cements was not large enough to justify a definite conclusion concerning their relative merits for the particular purpose at hand, it appeared that Bakelite XJ 16320 was most likely to give the best results. Cycle-Weld C-3 Brush Type did not arrive in time to receive as much attention as it deserved, and Cycle-Weld C-B-4 Brush Type arrived too late to be used at all. For these reasons, most of the work was done with the Bakelite cement.

In the earlier work, psi values were usually around 1000 to 1500. As one improvement after another was made, the psi gradually crept up to a maximum of 6700. This was obtained only once, but work was stopped at about that time. At the end, values above 5000 were fairly well assured. However, even when the highest values were obtained, there was still appreciable bubble formation so that probably less than one-quarter of the total area used in calculating the psi was actually effective.

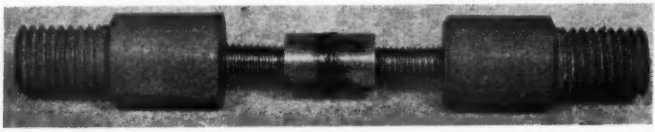

Fig. 16. Test piece assembly including cylinders cemented together and attached to adaptor for tensile test machine

Through continued work it might be possible to eliminate the bubble formation completely in which case the tensile strength of the cement might be greater than that of some of the plated coatings and base metals. In the later experiments, the adhesion was 100 per cent. Of course, if bubble formation had been completely eliminated, the adhesion might not have been high enough.

It is possible that through cooperative work with cement manufacturers some cement could be developed which would be more suitable for this application.

It has been reported that for some purposes cements are now being used in place of spot welding.

What Is "Perfect" Adhesion and "Perfect" Bond?

An observation made during the analysis of both literature and private communications deserves some consideration here. It concerns the various meanings which different platers have in mind when they use the expressions "perfect adhesion" and "perfect bond." Perfect bond or perfect adhesion certainly cannot be expressed as one definite number of pounds per square inch; the very nature of adhesion is such that perfect bond between one coating and one base metal would be of a very different magnitude from that between another coating and the same base metal or the same coating and a different base metal.

If there can be no absolute value in psi for a "perfect" attachment, then the question arises as to the exact meaning to be attached to the word "perfect" when used in connection with degree of attachment of plate to base metal. It has been suggested that "perfect" should apply whenever the degree of attachment completely meets the requirement for the particular use to be made of the part; for example, if an attachment represented by 5000 psi is all that would ever be needed for a given plate on a given base in actual use, then 5000 psi is "perfect" for all practical purposes. Some other use of the same coating-base combination might require 10,000 psi to assure complete satisfaction, and then 10,000 psi should be regarded as "perfect."

An excellent discussion of this subject is given by Dr. Charles L. Faust in the March, 1946 issue of THE MONTHLY REVIEW. His suggestion that "it would be well to consider distinguishing between adhesion and bond strength" is worthy of serious consideration. The following distinction is suggested:

"BOND STRENGTH would be measured by the force required to separate the plate from the basis metal regardless of the place of fracture and would be distinguished from ADHESIVE STRENGTH which would be measured by the force required to separate the plate at the interface between itself and the base metal surface. As thus defined, the adhesive strength may exceed the bond strength, but the latter could never be greater than the former."

This clear and definite distinction is a highly commendable step in the right direction. In actual practice some question may arise when the fracture is carefully studied in that it may show both types of separation at the same time.

Personally, I find the use of the word adhesion to be somewhat distasteful since popular usage has attached to it the concept that a physical as contrasted to a chemical force is involved. In an earlier part of this discussion, the attempt was made to convey the idea that the force which holds an electrodeposit to the base metal is the force between atoms which is a valence or chemical force. It must certainly be true that the strongest possible bond is the one in which an alloy layer has formed between the plate and base metal or one in which the crystal structure of the base metal is continued into the plate. To use the word adhesion in connection with such bonds is to give it a different meaning from that in popular use. In some parts of this discussion, the expression "force of attachment" has been employed. Making use of an expression similar to the metallurgist's "tensile strength", the plater might talk about "attachment strength". This broad term might be divided into a tensile bond strength and interface bond strength.

The Electroplaters' Society might do well to consider standardization of the usage of several terms and expressions by members. At least something should be done to clarify the present confusion.

CONCLUSIONS

1. Failures of electrodeposits are more often due to porosity and lack of adhesion than to too low a thickness. Thus specifications for adhesion and porosity are more important than for thickness.

2. The actual need, especially by the practical plater, for a quantitative method which expresses adhesion in psi is not great.

3. There is a serious need by the practical plater for a non-destructive production test which will provide continuous assurance that his particular product will give customer satisfaction when it is used for the purpose and under the conditions intended.

4. The bend test is the one most extensively discussed in the literature and still is the most popular one in shop practice.

5. If bend tests are to be considered, then one should be used or developed which is most likely to assure satisfaction when the part is used in the normal way.

6. As a general statement concerning simple bend tests, the series illustrated in Fig. 2 probably gives the best relative values for shop practice and is also very effective.

7. For articles which must withstand unusual forming operations or conditions of use, unusually drastic bending and twisting tests have been developed which will assure satisfaction on the part of the customer.

8. Burnishing, which is a regular operation in some plating industries especially on thin deposits of silver and gold and even nickel, is generally considered a sufficient test for the applications in question.

9. Impact or hammering tests are highly effective for certain usages of plating, but their field of use is very limited.

10. The so-called B. N. F. adhesion tester has no other value than to show an entire lack of bond which it does very conveniently.

11. The improved shot impingement test led the inventor, F. D. Hallworth, to make this very significant statement: "At this writing, it appears to be the most adaptable test available for checking silver adhesion", and he had been testing 0.025 inch thick deposits in regular production for many years.

12. Heating tests are highly effective where applicable. They are of two distinct types. One makes use of straight heating and serves to expand absorbed or occluded gas or liquid under the plate or in the base metal. If the adhesion is not very good, the plate is pushed up in the form of blisters. The other consists in a rapid and big change in temperature which causes the plate to loosen provided its co-efficient of expansion is appreciably different from that of the base metal.

13. The "black light" or fluorescent test has no practical value as a test for adhesion except in a few special cases. When properly carried out, it does give valuable information concerning porosity and does show complete absence of bond at edges of plated parts.

14. The Erichsen and other extrusion tests have no practical value as a means for judging adhesion except in highly specialized cases.

15. The scratch or scratch-and-knife tests should be displaced, except for very special cases, by more effective methods.

16. The chisel test is exceedingly drastic and reliable especially for thick deposits. A suitable procedure should be developed for each application.

17. The grinding wheel test is quick and simple. It is very popular with many of the most competent platers and is considered by them as highly effective except for very brittle or very soft deposits. It should, however, be used only by an expert operator.

18. The can-opener test permits considerable standardization and thus provides a fairly good comparison between the degree of adhesion of various samples. It is valuable for experimental work.

19. The Jacquet test employs much the same principle as the can-opener test, but is somewhat more scientific and capable of giving more nearly quantitative information. It is primarily a method for experi-

mental work. The interpretation of the results is questionable.

20. The various modifications of the Ollard test are the only ones that deserve to be called quantitative and even they are open to some question. They are suitable only for research and can be applied only to heavy deposits preferably thicker than 0.02 inch. Several modifications of the Ollard test have been developed. The most outstanding with which the author is familiar were developed in the research laboratories of International Nickel Company, Chrysler Corporation, United States Rubber Company, and Allison Division of General Motors Corporation.

21. The supersonic method, at least in the present stage of its development, can be used to detect only actual gaps between plate and base metal. It was intensively studied during the war and is still being investigated.

22. The X-ray test is in the same class as the supersonic test and about equally effective. Both have the outstanding advantages of being non-destructive and applicable to commercial production, but both are expensive to install and to operate.

23. Some form of tensile test in which a handle is attached to the plate so as to provide a direct pull, has been in use since the first one was proposed in 1905.

24. The direct tensile test in which the handle is soldered to the plate was early discarded but is coming back into production use where the plated object must withstand a high temperature.

25. The direct tensile test in which the handle is attached by adhesion is extensively used today as a qualitative test.

26. A strong feeling has been expressed by several prominent platers that a quantitative method for measuring adhesion through the use of adhesives might be developed which would have considerable application.

27. The experimental part of the project thus far completed has demonstrated the possibility of measuring adhesion up to 6000 psi through the use of adhesives.

28. Bubble formation in the final curing operation cuts down the effective area of the adhesive cement to about one-quarter of the possible area. If bubble formation could be prevented and the present tensile strength of the cement retained, it might be possible to raise the total tensile strength of the cement to about 25,000 psi.

29. It is recommended that the Electroplaters Society give attention to the clarification of the confusion now present in the use of some common words such as adhesion, degree of adhesion, bond strength and "perfect adhesion" as applied in the plating industry.

30. The strongest type of adhesion is that in which the atoms of the plated material are combined chemically with the atoms of the base metal. Such a combination is indicated when the crystals of the plate grow as continuations of the crystals of the base metal. This happens only when the base metal is chemically clean at the time when the plating starts. Because of these considerations, the author believes that the greatest source of difficulty in obtaining satisfactory adhesion results from insufficient cleaning and rinsing before plating. If the cleaning and rinsing are thoroughly done and the time between rinsing and the start of plating is short, the difficulty with poor adhesion should be reduced to a minimum.

Apology

In the May, '46, issue of THE MONTHLY REVIEW, a book review by Dr. H. J. Read commented adversely on the book "Surface Active Agents—The Oretical Aspects and Applications" by C. B. F. Young and K. W. Coons. Subsequently a letter was received from one of the authors justly protesting the tone of the book review and stated that the book had received favorable comments in other book reviews. The author contended in his preface that the book is written to help men in industry. That it failed to satisfy a jury of scientists does not in itself discredit the book. Its value "will out" and the REVIEW regrets any unjustice done it.

EDITOR.

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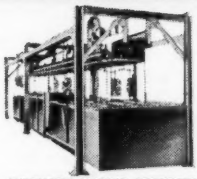
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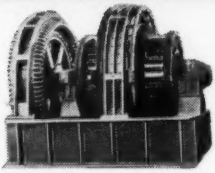
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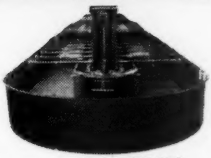
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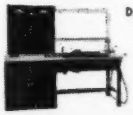
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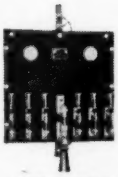
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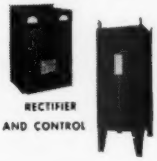
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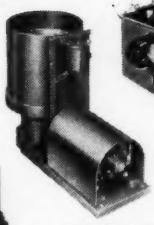
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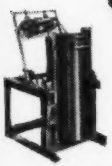
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Burnishing	( )	Chromium	( )	Enameling	( )
Burring	( )	Copper	( )	Galvanizing	( )
Cleaning	( )	Lead	( )	Japanning	( )
Degreasing	( )	Nickel	( )	Magnesium	( )
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Have you returned yours? These facts are needed to classify our readers and the industries they serve so that the Society can do a better job in selling advertising in THE MONTHLY REVIEW. Won't you please answer the questionnaire, using the card or above form, and mail as soon as possible?

We Need Your Cooperation!

Readers' Corner

Comments on "Copper Plating from Fluoborate Solutions," September, 1946, MONTHLY REVIEW.

Mr. A. E. Carlson
General Chemical Company
40 Rector Street
New York, N. Y.

DEAR MR. CARLSON:

It is extremely gratifying to read a paper on a new plating process which discusses the influence of the various operating conditions in as great detail as yours did. I think that the paper might well serve as a model to be followed by all workers in the field.

The data shown graphically in Fig. 4, "effect of current density on voltage across a cell," undoubtedly represent the facts as you obtained them. However, in deducing from those data the fact that the polarization at the measured electrode is small you are apparently neglecting to correct for the IR drop through the solution. If the polarization is small at the measured electrode, as it apparently is, the deviation from a straight line obtained when cell voltage is plotted against current density would be small. Careful examination of your data indicates that such deviations due to polarization may well exist but may be masked by other factors inherent in the experimental technique. This view is corroborated by the coincidence of the curves obtained when the smaller electrode is either anode or cathode.

While I am quite sure that you are well aware of the foregoing factors, the misconceptions prevalent in the literature of plating with respect to the definition and measurement of polarization may be heightened by the apparent oversight on your part.

The foregoing comments, you realize, are of a minor nature. I do not think that they detract in the slightest from the very commendable job you have done.

Very truly yours,

H. BANDES,
Engineering Research Department,
Sylvania Electric Products, Inc.

●

Sylvania Electric Products, Inc.
34–10 Linden Place
Flushing, N. Y.

Att.: Dr. H. Bandes, Engineering Reseach Department.

DEAR DR. BANDES:

We appreciate your comments regarding our recent paper, "Copper Plating from Fluoborate Solutions," and agree that the IR drop affects the accuracy of our polarization data. The method as employed is not recommended for accurate polarization measurements. It is a rapid means of exploring qualitatively the variations of polarization over a wide range of current densities. At the same time any filming and excessive cyclic polarization at the anode is indicated. Furthermore, conventional polarization methods such as the Haring cell or exploratory half cell are seriously limited at high current densities.

The method was first mentioned to our knowledge by Graham and Read in their paper on "Rochelle Copper Plating Baths". Its accuracy is increased by reducing the size of the electrode under investigation in relation to the other electrode, thus reducing the total current on the cell required to give the desired current densities.

We agree that readers should be cautioned regarding the interpretation of these data and are, therefore, requesting the editor of the MONTHLY REVIEW to publish this correspondence.

Very truly yours,

A. E. CARLSON,
Engineering Service Division,
General Chemical Company.

YOU ARE INVITED

to submit a paper on some phase of electroplating or its allied arts to the

Educational Committee

in charge of the Technical Sessions to be held as part of the

1947 A. E. S. CONVENTION
Detroit, Michigan
June 23 to 26, 1947

Please advise the chairman as quickly as possible if you plan to submit a paper stating title and author.

Manuscripts should be submitted as early as possible in order to receive favorable consideration by the committee. March 1, 1947 is the deadline.

All manuscripts and communications should be sent to

Dr. R. B. Saltonstall
Chairman, Educational Committee
1651 E. Grand Blvd.
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ADDRESSES DESIRED

We are anxious to obtain the addresses of the following members. Their copies of THE MONTHLY REVIEW have been returned to us with such notes as "not here," "wrong address," and "unclaimed."

Please run through the list! If you find the name of a friend whose new address you know, drop a post card to Box 168, Jenkintown, Pa. It will be much appreciated.

BALTIMORE–WASHINGTON BRANCH
Charles H. Singstack, 35 Seaton Place, N. W., Washington, D. C.

BOSTON BRANCH
Eleanor Basque, 132 West St., Leominster, Mass.
Elliott Charney, 60–06 Myrtle Ave., Brooklyn 27, N. Y.
George Fairbairn, 14 Rutland St., Cambridge, Mass.

BRIDGEPORT BRANCH
Anthony Turko, 230 South Ave., Bridgeport, Conn.

BUFFALO BRANCH
Zina Cummings, Chartlottville Rd., Newfane, N. Y.

CLEVELAND BRANCH
Charles Huberty, 514 Wells Ave., Canton, Ohio

DETROIT BRANCH
N. W. Hovey, 11000 Mack Ave., Detroit 14, Mich.

GRAND RAPIDS BRANCH
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John Manning, 1270 Gass Ave., S. E., Grand Rapids, Mich.
E. G. Prefontaine, 707 Fountain, N. E., Grand Rapids, Mich.

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George R. Merrian, 289 S. Cherry St., Wallingford, Conn.

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Joseph Simon, 2301 Kings Highway, Brooklyn 29, N. Y.
Michael Yacco, 73 Harding Ave., Clifton, N. J.

PITTSBURGH BRANCH
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Percy A. Goldsmith, 1459 Fourth Ave., New Brighton, Pa.

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George H. Hibbard, 543 Central Ave., Rochester 5, N. Y.
Renato Silva, Union Polishing Plating Co., 14 Commercial St., Rochester, N. Y.

ST. LOUIS BRANCH
Henry Hurtig, 1215 N. 23rd St., Milwaukee 5, Wis.

(*Continued on Page 1339*)

Copper Plating

(*Continued from Page 1276*)

processes will cause failure if the temperature is allowed to rise above the melting point of copper. In the box carburizing furnace, the parts are packed with coke impregnated with activators. Unless the coke is sulfur free, the sulfur will attack the copper at the carburizing temperature which may lead to penetration and, in addition, cause the copper to run

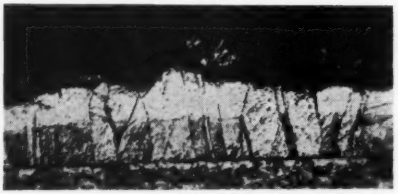

Fig. 11. Typical structure of copper plate after treatment in the homo carburizing furnace. Note the thin layer of flaked copper. Base metal etched with 3% nital, copper etched with ammonium hydroxide-hydrogen peroxide. X100

over the areas to be hardened. The latter condition results in insufficient case depth.

The principle of the gas carburizing furnace is the cracking of organic fluids which furnish carbon monoxide, carbon dioxide, and other break down products. This atmosphere is normally reducing and non-injurious to copper. However, when the load is first put in the furnace, or when there is an air leak in the furnace, a decarburizing atmosphere may come in contact with the copper and cause it to oxidize. (See Figs. 11 and 12.) The cover should be put on the furnace, the fluid turned on immediately and the leaks plugged, or the copper may oxidize to such an extent as to be subject to penetration. Since a thin layer of copper usually becomes oxidized in the homo carburizing furnace, it is generally wise to apply slightly heavier coatings of copper when this type of furnace is to be employed.

The above information on furnaces is very general. Both methods, particularly homo carburizing, are accompanied by very complex reactions which may or may not have an effect on copper plate. However, with careful control, little trouble will result.

Conclusion

It is apparent from the foregoing discussion, that there are many possibilities for copper plate to fail as a mask in selective carburizing. In some instances, failure is inevitable even before plating. In others, the copper plating technique or the technique following the application of plate will cause hard spots on those areas intended to remain soft. Only by concerted effort of all processors involved can elimination of difficulties be expected.

Fig. 12. Oxidation in carburizing furnace causing formation of thin flaked layer and deep attack. Base metal etched with 3% nital, copper etched with ammonium hydroxide-hydrogen peroxide. X100

Society Publications

Files of the Society's publications, complete with few exceptions, are now available at the following institutions which are equipped to supply photostatic copies of any articles desired:

The Library of Congress, Washington, D. C.

The Free Library of Philadelphia, Logan Square, Philadelphia, Pa.

The Enoch Pratt Public Library, Baltimore, Md.

We hereby gratefully acknowledge receipt of back issues of the Society publications during the past month from the following:

Sulphur Products Company, Greensburg, Pa.; Hamilton Watch Company, Lancaster, Pa.; Northwest Chemical Company, Inc., Detroit, Mich.; and George Gehling, Philadelphia Branch.

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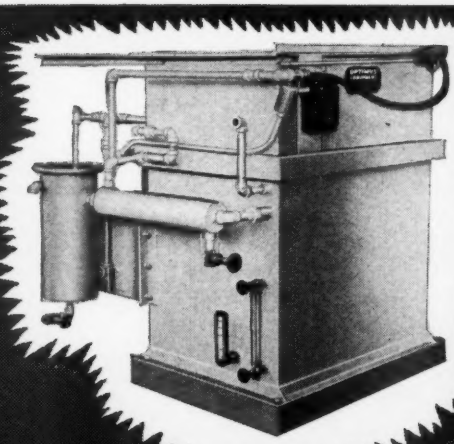

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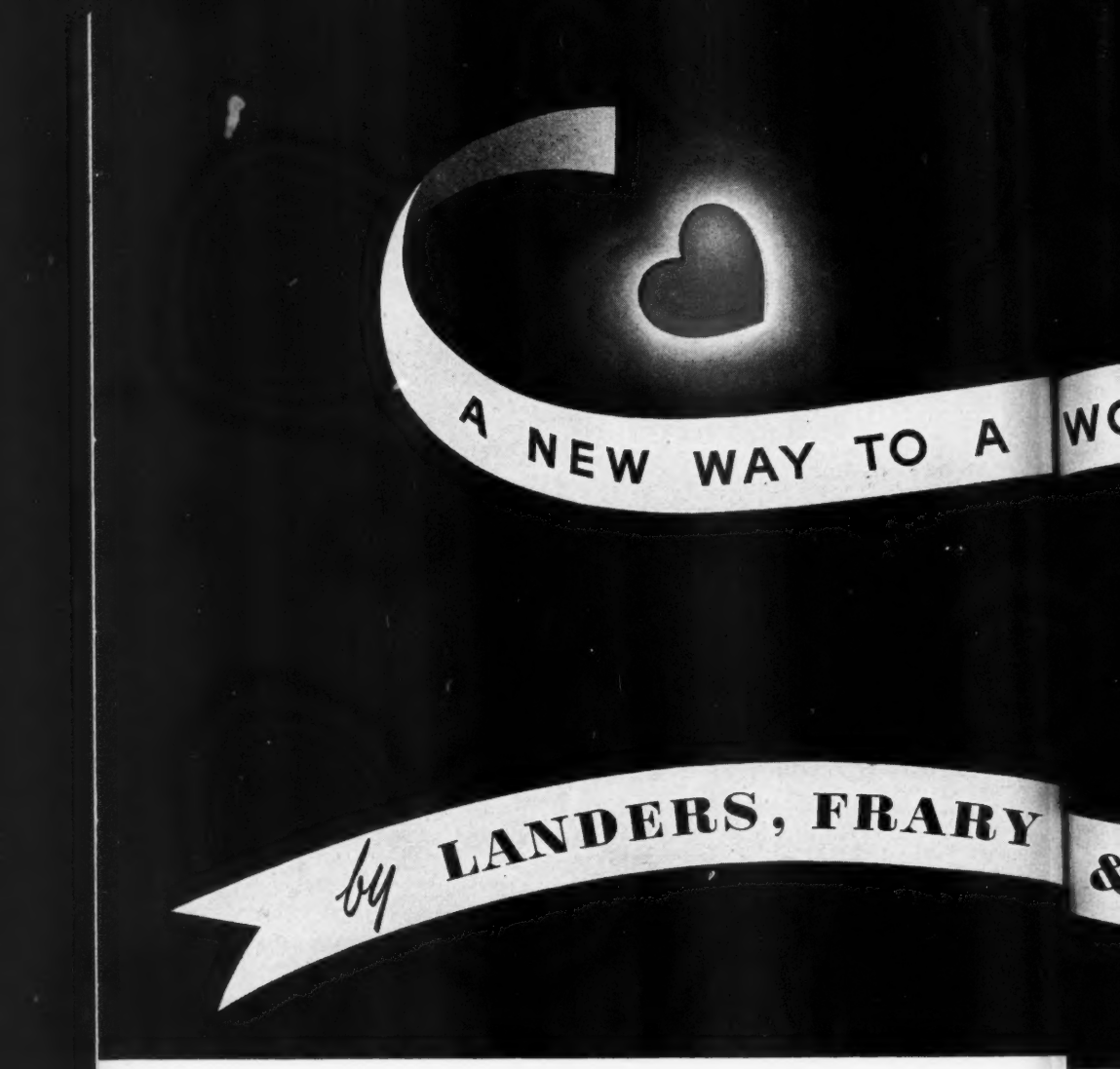

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ALUMINUM COMPANY OF AMERICA (c)
Pittsburgh 19, Pa.—East and Midwest

R. E. PETTIT, Engineer
C. J. HINTON, Engineer
Subject: *Finishing Aluminum* (with motion pictures)

THE AMERICAN BRASS CO. (c)
Technical Department, Waterbury 88, Conn.—East and Midwest

JOHN R. FREEMAN
Subject: *General Properties of Copper and Its Alloys*

AMERICAN INSTRUMENT CO. (c)
8010–8020 Georgia Avenue, Silver Spring, Md.—East and Midwest

C. E. OHLHEISER, Development Engineer
Subject: *Correct Application For, The Use and Care of the Magne-Gage and Filmeter* (illustrated with slides)

DOEHLER–JARVIS CORP. (c)
Grand Rapids 2, Mich.—East and Midwest

MAURICE CALDWELL, Chief Technician
Subject. *The Cleaning of Zinc Base Die Castings Prior to Electroplating*

ELECTROCHEMICAL INDUSTRIES, INC.
33 Herman St., Worcester, Mass.—East (c) West and Central (partial b)
HAROLD NARCUS, President and Technical Director
Subject:
The Deposition of Metals on Plastics

INDUSTRIAL FILTER & PUMP CO. (c)
609 W. Lovell Street, Kalamazoo 46, Mich. —Midwest

HAROLD W. FAINT, Sales and Service Representative

Subject: *Filtration and Purification of Electroplating Solutions*

MACDERMID, INC. (c)
Waterbury 88, Conn.—East and Midwest
HENRY STROW

Subjects: *Bright Nickel Plating* and *Cleaning Subjects*

NATIONAL CASH REGISTER CO. (c)
Dayton 9, Ohio

W. E. MOLINE, in charge Plating Laboratory

Subject: *Electrolytic De-Burring*

NUTMEG CHROME CORPORATION
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A. W. LOGOZZO

Subject:
Bright Nickel and Decorative Chrome Plating

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HAMILTON ALLEN, Works Laboratory Administrator, Subject 1
FRANK MESLE, Superintendent Bearing Division, Subject 2

Subjects:
1. *Rejuvenation and Recovery of Silver-Plating Solutions*
2. *Thick Silver Deposits*

WESTERN ELECTRIC CO., INC.
Hawthorne Station, Chicago, Ill.—East or Middlewest.

A. C. JONES, Engineer of Manufacture
DR. R. E. HARR, Subject 1
R. V. MINER, Subject 2
F. B. RINCK, Subject 3

Subjects:

1. *Theory and Practice of Electrodeposition Including Such Metals as Gold, Silver, Tin, Zinc, Copper, Nickel, Chromium.*
2. *Current Industrial Plating Methods, Particularly by Means of Semi-Automatic Equipment, of Zinc, Nickel and Chromium.*
3. *Layout and Operation of Modern Electroplating Equipment.*

THE ENGINEERING FUTURE OF PLATED BEARINGS

(*Continued from Page 1283*)

3. Electroplating has produced bearing alloys with metallurgical properties that cannot be obtained by the thermal processes. However, it is also true that certain types of bearing alloys can be prepared by thermal procedures but not by electrodeposition procedures.

4. The metallurgical uniformity of successful electroplated bearing materials usually exceeds that of equivalent thermally prepared alloys.

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Payments to Research Fund Deductible

Payments to A.E.S. Research Fund whether in the form of Sustaining Membership dues or contributions are deductible income tax items. The following paragraphs are quoted from an official Treasury Department communication dated April 2, 1946, and signed by the Acting Deputy Commissioner, ruling upon the Society's income tax status:

"Contributions made to you are deductible by the donors in arriving at their taxable net income in the manner and to the extent provided by section 23 (o) and (q) of the Internal Revenue Code, as amended, and corresponding provisions of prior revenue acts.

"Bequests, legacies, devises or transfers, to or for your use are deductible in arriving at the value of the net estate of a decedent for estate tax purposes in the manner and to the extent provided by sections 812 (d) and 861(a)(3) of the code and/or corresponding provisions of prior revenue acts. Gifts of property to you are deductible in computing net gifts for gift tax purposes in the manner and to the extent provided in section 1004(a)(2)(B) and 1004(b)(2) and (3) of the code and/or corresponding provisions of prior revenue acts."

EDITOR.

Have You Seen The Invitation On Page 1307?

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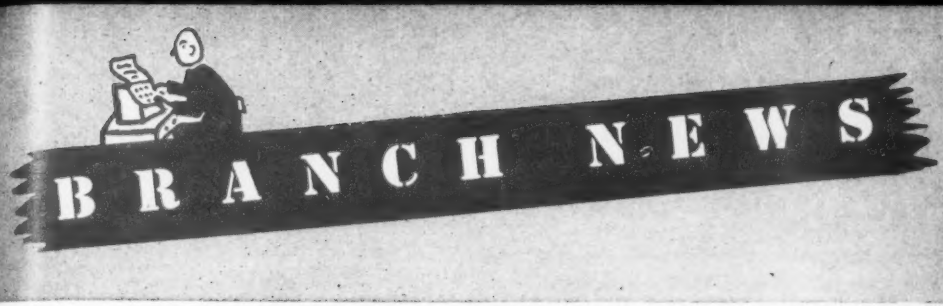

MONTREAL BRANCH

The monthly meeting of the Montreal Branch was held on Friday, October 18, after a postponement due to the regular meeting night falling on a holiday. The President opened the meeting with 16 members and guests present, a 35% drop from our last meeting.

The Educational Session opened with the Librarian introducing the guest speaker, J. GUFFIE of United Chromium Corp., who spoke on "Copper Plating from Pyrophosphate Copper Solutions". Samples were exhibited showing the fine structure and throwing power of the deposits from this type of solution. The following discussion brought out some very interesting data on the cathode passivation due to organic compounds used in acid copper solutions. A hearty vote of thanks goes to Mr. Guffie for the fine talk, and a request for some literature on the subject.

The business session followed with R. E. GORDON giving a short report on the failure of the hotel to adhere to its promise to accommodate the 1947 convention.

One application for membership was accepted.

The letter on the questionnaire for THE MONTHLY REVIEW was read to members and the importance of this matter was stressed to all present.

WM. GLOVER,
Secretary.

●

GRAND RAPIDS BRANCH

The Grand Rapids Branch held one of the most significant meetings of its history this month. The meeting marked the first effort of the Branch, as a body, to make a contribution, other than monetary, to the fund of knowledge being accumulated through the Research Program. We were fortunate in having B. C. CASE with us to give a short resume of the purposes and accomplishments of the Research Program, especially those of Subcommittee No. 5, which is working on the problem of the contamination of plating baths. We held a round table discussion following Mr. Case's remarks, and the members were able to make numerous suggestions regarding possible lines of investigation that had not heretofore been considered.

We feel that this kind of a meeting is one of the best ways of carrying out a most important function of the Society, as it makes possible the gathering together and publishing of valuable information which otherwise would be unavailable. The information that was contributed by the members at this meeting will be incorporated in later reports and, for this reason, we do not feel that it is proper to publish it at this time.

RANSOM B. PERKINS.
Secretary.

●

LOS ANGELES BRANCH

The Los Angeles Branch held its regular meeting on October 14, 1946, the price per dinner plate was upped again, this time to $2.00, tip extra. Turkey was served and no complaints were registered. Approximately 60 attended the meeting, including guests.

Four candidates were elected to membership.

M. C. WELKER, Ion-Exchange Products Department, American Cyanamid Company, New York City, spoke on the use of deionized water in the plating room. The use of deionized water was recommended not only for

the make-up of plating solutions, but also in the rinse following the acid dip prior to plating and the final rinse after plating. The cost of regenerating chemicals required for deionization of tap water (believedto be Los Angeles tap water) was quoted as $0.14 per 1000 gallons. Several cases were cited where spotting of finished plated ware was eliminated by use of deionized water in the final rinse.

PRESIDENT ELDRED opened a discussion regarding what should be done to improve the Annual Educational Session and Dinner Dance and to improve the attendance of the active members of the Society at the banquet. The consensus of opinion was that the affair as conducted in the past several years established a fine tradition and no significant change appeared to be indicated. However, ELMER RICHARDSON pointed out that a more central location would be worth looking into.

M. D. RYNKOFS presented JOHN MERIGOLD, who had just returned from New Jersey, to describe what he saw of the reaction of the Newark Branch to the International A.E.S. Convention to be held in Los Angeles in 1948. Mr. Merigold mentioned a letter from the L. A. Branch to the Newark Branch asking the latter to step aside in favor of Los Angeles. The Newark Branch voted to step aside in favor of Los Angeles and to step back in place again should Los Angeles give it up. The Newark Branch questioned that Los Angeles could draw a good attendance, however, and were sending a reply to Los Angeles expressing these opinions. ERNIE LAMOUREUX volunteered that it was he and not the Los Angeles Branch who had written that letter, that it was on his own private stationery, and that said opinions were his own and were not represented as being the official action of the Los Angeles Branch.

The Secretary was ordered to send a get well card to our member C. G. SPENCE, who was injured in a recent airplane accident.

E. R. HOLMAN,
Secretary-Treasurer.

●

SYDNEY BRANCH

The regular monthly meeting was held on October the 8th, 1946, at the Chamber of Manufacturers.

In the business session one applicant was elected to membership.

LIBRARIAN HEARD introduced MR. SIDES as the speaker for the evening. Mr. Sides delivered a talk on the use of Abrasives in the Polishing Room. Considerable discussion was held on the talk in which some of the methods used in America were described by the speaker.

Plans were made for the Annual Social to be held in December to mark the end of the year.

Branch members are asked to attend the meetings in 1947 so as to ensure the success of the future activities of the Society.

J. R. GODFREY,
Secretary.

●

CLEVELAND BRANCH

At a meeting of the Cleveland Branch of the American Electroplaters' Society, held October 4, 1946, in the Cleveland Hotel, Cleveland, Ohio, five men were elected to membership.

The speaker of the evening was W. H. HOOVER of the Mine Safety Appliance Company of Pittsburgh, Pa. In connection with his talk on "Safety and Safety Equipment In The Plating Room", Mr. Hoover presented a very interesting and instructive film entitled "The Air We Breathe". He outlined the development of respirators for use in industries producing contaminated atmospheres. It was evident from his talk that the present day respirators not only clarify the air but are made to fit the individual so that they will be comfortable throughout the working periods. Various types of cartridges or filters are available for the removal of noxious fumes as well as dust particles. There were also displayed other types of safety equipment for the plating and pickling rooms.

A rising vote of thanks was extended to Mr. Hoover for his excellent talk and the meeting then adjourned.

GEORGE B. SVENSON,
Secretary-Treasurer.

●

WATERBURY BRANCH

Waterbury Branch held its regular monthly meeting Friday, October 11, 1946, at 8:00 P. M., in the Colonial Room of the Hotel

Elton. Following the practice of previous years dinner was served to members and guests in the Colonial Room at 6:30 P. M. The Technical Session opened promptly at 8:00 P. M., with over 50 present.

President BERT SAGE asked RALPH COLTER to report on the activities of the Educational Committee relative to its development of a program for presentation to the Branch during the winter and spring months. The Committee has decided that a round table discussion on various practical aspects of plating would be worth while. It was suggested that discussion groups be held once a week with an expert on the particular subject considered acting as leader. A number of members expressed interest in such a program and a detailed plan will be presented at the next meeting.

GEORGE DUBPENELL reviewed the eighth and newest edition of "*Galvanotechnik*". This German work on electroplating by W. PFANHAUSER is now available in the United States and is the most extensive work of its kind. It is an excellent book going into all phases of electroplating in great detail. However, it is a largely a literature review and shows that the Germans had great respect for American methods in plating.

Covering new developments, HENRY STROW discussed briefly the German rectifier, developed during the war which converts AC to DC current mechanically and which operates at high efficiency in the lower voltages.

Our movie for the evening was a new film released by the Aluminum Company of America describing in some detail methods and kinds of finishes obtainable on aluminum.

It was with a great deal of regret that we learned that FRANK SAVAGE was unable to get to Waterbury to deliver his paper on "Wage Incentives in the Plating Room". However, we were most fortunate in being able to get RAY O'CONNOR at very short notice to give a talk on "Sound Cost Control Procedure in the Job Plating Business". Ray showed the many factors to be taken into consideration and the methods of arriving at a true cost in plating and finishing. He also discussed briefly the wage incentive plan which operates in his plant. After a question period the Branch expressed its appreciation for having the opportunity of having such a fine discussion of this important subject.

S. L. HENN,
Secretary.

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CHICAGO BRANCH

The Chicago Branch of the American Electroplaters' Society held its regular monthly meeting at the Atlantic Hotel, on Friday, October 11.

A departure from our usual meeting procedure was very well attended. C. R. CRAWFORD, President of one of the large job plating shops in Chicago, The Chrome-Rite Company, presented moving pictures in color of two hunting trips he had taken in Utah. Some excellent shots of the scenery plus actual pictures of the lions in action were very well received by the people who attended. Since the number of lion hunters in the audience were distinctly in the minority, the novelty of actual big game hunting was a distinctive presentation.

Liquid refreshment was served after the meeting, beer for the stalwarts and soda for the weaklings—your reporter drank soda. We were going to have sandwiches, but the sandwich supplier was troubled with the shorts. All we could have had would have been jam sandwiches—two pieces of bread jammed together!

G. STUART KRENTEL,
Review Correspondent.

●

SAN FRANCISCO BRANCH

The October meeting of the San Francisco Branch was held at Victor's and Roxie's Cafe in Oakland, on October 11, 1946. Twenty-two members and six guests attended.

A report was made on arrangements for the December dinner party for members and wives. FRED HUNTINGTON was elected Exhibits Chairman. One new member, WM. E. ALEXANDER, was voted into the Branch Society. There was some discussion of a membership drive. It was decided that the November meeting would be guest night and each member was requested to attend and bring as a guest a prospective member.

There was considerable discussion of ways

and means of starting a class on plating for the benefit of the apprentices and new men in the industry. It was suggested that the individual shops might bear part of the expense of operating the class. Mr. Huntington was appointed to contact the University of California Extension Division regarding organization of such a class.

Three guest speakers addressed the meeting.

Mr. Carlson, Heating Engineer with the Pacific Gas and Electric Co., spoke on the "Heating of Plating Solutions". Mr. DePew, Heating Engineer with the General Electric Co., gave us a talk on the "Application of Electricity in Heating Solutions". Mr. Smith, with the Kraft Tile Co., spoke on "Application of Resin Linings for Plating Tanks".

Fred W. Huntington,
Secretary-Treasurer.

●

TWIN CITY BRANCH

The Twin City Branch of the American Electroplaters' Society met Monday, October 7, at 8:15 P. M., following dinner at the Covered Wagon Cafe in Minneapolis.

There were two new members of the Branch since last meeting.

Gunnar Deedon, Chairman of the Exhibits Committee, and President Lillicrop announced that the Branch was awarded first place at the 1946 Convention for our exhibit.

A. T. Leonard, Membership Chairman, gave a report on the 1946 Convention and also asked each member to bring in new members so the Branch may keep growing.

The speaker for the meeting was G. S. Krentel, of Arrow Plating Company, who spoke on "Cleaning of Metals Prior to Plating". The talk was most informative and well appreciated.

Robert L. Buckley,
Secretary-Treasurer.

●

SOUTHEASTERN BRANCH

The regular monthly meeting of the Southeastern Branch of the A.E.S. was held at the Robert Fulton Hotel on Thursday, October 10, R. E. Norman, presiding.

After some discussion on membership the following members were appointed to serve on the Membership Committee: Sidney Grandy, Fred Fletcher, and Charles Woolfolk, with M. E. Awtrey as Chairman.

Charles Woolfolk, of Southeast Chemical Co., Birmingham, Ala., was appointed Chairman of Exhibits.

Carl Cartlege, of Scripto Manufacturing Co., was appointed to work with M. E. Awtrey as Publicity Committee.

Our November meeting will be held in Birmingham, Ala., time and place to be announced at a later date.

Mr. Woolfolk spoke of the A. E. S. from a business standpoint, stressing the point of securing members from cities other than Atlanta in order to keep a growing Society.

Carl Cartlege was our speaker of the evenning speaking on fabrication and plating of small parts. Mr. Cartlege, being connected with Scripto Manufacturing Co., was not only in a position to make a very interesting talk but brought samples to illustrate his point.

Wm. T. Weymouth,
Secretary-Treasurer.

●

HARTFORD BRANCH

The Hartford Branch, AES, was host to the Hartford Chapter ASM, at the Hotel Bond, Monday evening, September 16, 1946, the occasion being the opening Educational Session of the 1946-47 season.

Fifty-two members and guests of both Societies enjoyed a turkey dinner in the Egyptian Room. The Educational Session was attended by 75.

Ted Voyda, President, turned the meeting over to Art Logozzo, Technical Chairman, for the evening. Art introduced the speaker, J. E. Williams, Jr., Metal Descaling Division, E. I. du Pont de Nemours, whose subject was "Sodium Hydride Descaling". The NaH is obtained by combining metallic sodium and hydrogen gas at high temperature. The process is operated at a temperature of 700° F. Some of the advantages pointed out were: no pitting of basis metal, no possibility of overtreatment, no metal

loss, parts easily washed, no current required, no hydrogen embrittlement. The talk was thoroughly enjoyed and many questions were asked of the speaker.

F. W. SMITH,
Secretary.

●

NEWARK BRANCH

The regular meeting of the Newark Branch, A. E. S., was held on Friday evening, October 4, 1946, at the Hotel Robert Treat in Newark, N. J. The meeting was called to order at 8:15 P. M., with President JOHN DEVRIES presiding. All officers except two members of the Board of Managers answered the roll call.

A communication from Third Vice President ARTHUR LOGOZZO, which was held over from the previous meeting, was re-read and turned over to EDWARD BOWERMAN, Chairman of Exhibits for Newark Branch to the 1947 Convention in Detroit. A communication from the Executive Secretary, A. KENNETH GRAHAM, with reference to having a die made for the Supreme Society for Gold Medals, was read and MR. SMITH stated that he had already communicated with Dr. Graham informing him that he would take care of the matter.

Two applications were voted to take the regular course. Eight men were elected to membership.

Mr. Smith and Mr. Wagner gave the final report on the Pittsburgh Convention. Mr. Smith next reported that he had received a letter from ERNEST LAMOUREUX asking him to use his influence in Newark Branch to support Los Angeles for the 1948 Convention. JOHN MERIGOLD, a member of Los Angeles Branch, who was in Newark on a visit, attended this meeting and was called upon for some remarks. John stated that he could assure us of a marvelous convention if Los Angeles should be fortunate enough to be selected as host. He mentioned trips to the movie colony and other places of interest and also assured us very good weather, stating that it never rains in California but that he had heard over the radio that morning it was raining like Hell out there.

The Branch voted to support the request at the next Convention. Mr. Smith next stated that he would call a committee meeting for the banquet and have a report for our next meeting.

Our guest speaker for the evening was Vice President HOWARD L. COBB, who gave a very interesting talk on "Electricity in the Plating Room". Howard had many illustrations and at the completion of his talk he was given a rising vote of thanks by the 43 members who attended this meeting.

GEORGE WAGNER,
Secretary.

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NEWARK BRANCH

It is our pleasure to announce the opening session of our 1946-47 open educational program. The first meeting is scheduled to be held on Saturday, December 14, at 2:30 P. M., at the Hotel Robert Treat, Newark, N. J.

With the return of our Nation to a peacetime economy, the need for educational program stressing peacetime methods in the plating industry has become highly imperative.

Bearing in mind this fact, our educational committee in its constant endeavor to present good educational programs with a view of obtaining the utmost in educational value on pertinent subjects, is proud to present the following list of speakers:

FRANK K. SAVAGE, *Supreme President.*
"Plating Room Incentive Systems"
Kuehne Manufacturing Company
Mattoon, Ill.

FRANK C. MESLE,
"Silver Plating"
Oneida Ltd.
Oneida, N. Y.

MYRON B. DIGGIN
"Purification of Plating Solutions"
Hanson Van Winkle Company
Matawan, N. J.

A Ladies Committee will be happy to entertain the visiting ladies during the afternoon session. The afternoon Educational Session is to be followed by a Christmas Party which will start at 8:30 P. M.

It has been our custom in the past to serve a buffet lunch to our members and guests at our Christmas Parties, but we wish to announce that due to the ever increasing at-

tendance at these parties it has become impossible to continue this practice.

This year our Committee, under the Chairmanship of HORACE H. SMITH, and with the able assistance of GEORGE WAGNER, GEORGE RUTER, WILLIAM BRUHNS, PAUL OLDAM, JOHN GUMM, WILLIAM HODECKER, JR., JOHN L. DEVRIES, GEORGE KLINK, and JACK GUNTHER, has decided to serve a turkey dinner. This is to be followed by a show plus a dance orchestra which will play for the evening. The price of admission will be $5.00 per person. If you wish to spend the day packed with education, good food, music and entertainment plan to be with us on December 14.

You are all cordially invited. "REMEMBER NEWARK BRANCH KNOWS HOW!"

Tickets may be secured and reservations for tables may be made by contacting our Secretary GEORGE WAGNER, 35 Fourth Street, Newark 7, N. J.

WILLIAM F. BRUHNS, *Publicity*
Educational Committee.

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SYRACUSE BRANCH

The Syracuse Branch meeting was held in Room 105, Bowne Hall, Syracuse University, September 20, 1946. It was called to order at 8:20 P. M. with 20 members in attendance.

DWIGHT OVERCASH'S resignation as Librarian was accepted with regrets. PAUL SWARTZ was unanimously elected to fill the librarian office vacated by Mr. Overcash. Three new members were elected to active membership in the society.

A letter from FRANK K. SAVAGE, Sub-Committee No. 5, A. E. S. Research Program, asking us to collect information from our members on the subject of "The Effect of Impurities and Purification of Electroplating Solution", was referred to the Librarian for future action.

A letter from ART LOGOZZO requesting our appointment of an Exhibit Chairman was referred to GEORGE SIMMONS.

Proposal was made from the floor that questions on technical problems be submitted at the meeting for study as is being done in other branches. This was referred to the Librarian.

A telegram from the speaker of the evening, K. TATOR, was read, in which Mr. Tator regretted his inability to speak owing to sickness.

The speakers of the evening were CHARLES BONN on the subject of "Automatic Buffing" and DR. N. F. MURPHY on "Phosphatizing".

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BRIDGEPORT BRANCH

The regular monthly meeting of the Bridgeport Branch of the American Electroplaters' Society was held Friday, Octo-4, 1946 at 8:00 P. M. at the Hotel Barnum. President H. M. GOLDMAN opened the meeting with 37 members and guests present. We were also honored with the presence of ELLSWORTH T. CANDEE, Chairman of the Research Committee, and DR. H. L. KELLNER, Sub-Committee Vice-Chairman assisting the Eastern Branches on obtaining Sustaining Members.

The roll call of officers was read and seconded. Vice-President C. L. TEMPLE, Librarian CARL SCHAEFER and Sergeant-at-Arms JAMES MCGRATH were reported absent.

RAY KWASNIK and WILLIAM EHRENCRONA of the Outing Committee gave us a final report of the Bridgeport Branch Outing, which was held September 21, 1946 at Eichner's Grove, Trumbull, Conn. We had a poor attendance due to rain, but the food and refreshments were good. There were games of various kinds including card games and everyone present enjoyed the affair immensely.

F. B. GOTTHARDT, Chairman of the Committee to locate a suitable meeting place for our Business and Open Meetings, will report at some future date.

The Membership Committee reported two persons for balloting and eight applications for membership. There were two suspensions for non-payment of dues.

The Sick Committee reported MRS. JOHN HELMLE, mother of our member C. C. HELMLE, ill in the Bridgeport Hospital. We all hope for a speedy recovery from her illness.

A. R. MCNEIL of the Projector Commit-

tee reported that the film and sound projector is in very good shape and is available to any member of our Branch.

The Educational and Technical Sessions Committee reported that an Open Meeting will be held Friday, October 18, 1946, at 8:00 P. M. at the Burroughs Library Auditorium, State and Broad Streets, Bridgeport. The speaker will be E. J. Roehl of the International Nickel Company and the subject is "The Engineering Uses of Electrodeposited Nickel".

A letter from Third Vice-President Arthur W. Logozzo pertaining to a plan calling for a manufacturer's plating equipment exhibit plus the usual Branch and individual displays was read. An Exhibit Committee will be appointed by the President under the heading of new business.

A letter from the New Haven Branch to attend the October 15, 1946, meeting concerning a talk on the waste disposal problems was ordered to be placed on file.

A letter from C. E. Heussner, Chairman of the Research Sub-Committee on Finance in the Eastern group of the American Electroplaters' Society, was also read. Eighteen Branches are in this Eastern group.

President Goldman has appointed the following to the Exhibit Committee: Frank Kalafus, Chairman; Ray J. Kwasnik and A. R. McNeil.

At this point President Goldman called upon H. L. Kellner, Vice-Chairman of the Research Sub-Committee on Finance to speak on the future progress of the Research Committee. Mr. Kellner placed high value on the necessity of supporting all Research Programs and has asked for full cooperation and effort by all of the Branches of the A. E. S. to support this program. Mr. Candee, Chairman of the Research Committee, spoke of the tremendous job involved but thinks that the time and effort placed into this program is fully justified by knowing how some of the problems in the plating industry can be solved and effected. Five projects are now tentatively placed into the Eastern Branches and requests are made to have committees appointed in each Branch to support the Research Program. After a thorough discussion the President commented that he will appoint a committee at the next business meeting.

J. G. Sterling,
Secretary-Treasurer.

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BRIDGEPORT BRANCH

An Open Meeting and Educational Session was held Friday, October 18, 1946 at 8:30 P. M. at the Burroughs Public Library Auditorium, Broad and State Streets, Bridgeport, Conn.

H. M. Goldman, President, opened the meeting with 32 members and guests present and, after a few remarks, called upon Carl Schaefer, Librarian, to preside as Technical Chairman of the evening.

Mr. Schaefer, after a brief talk, introduced E. J. Roehl, Chemical Engineer of the International Nickel Company, whose subject was "The Engineering Uses of Electrodeposited Nickel". Mr. Roehl has had considerable experience with the general nickel plating problems and is very well qualified to speak on this subject. During the course of his talk with the illustration of slides, Mr. Roehl pointed out many advantages obtained by the use of nickel plating, including corrosion resistance and building up of undersized parts which in many cases have proved superior and longer lasting than the original parts themselves. Many questions were asked which were ably answered by Mr. Roehl. After a lively discussion which proved interesting to all who had attended, a rising vote of thanks was accorded to Mr. Roehl.

Joseph G. Sterling,
Secretary-Treasurer.

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SYRACUSE BRANCH

The Syracuse Branch meeting was held in the Museum, Lyman Hall, Syracuse University, on October 25, and was called to order at 8:15 P. M.

The Membership Committee was appointed by the President, Neil Maffei, as follows: I. Psyck, Chairman, L. Wood and H. Gerhardt.

The Exhibits Committee was appointed by the President and consists of the follow-

ing: G. SIMMONS, Chairman, G. CAVANAUGH and H. HOLBERT.

A proposal to arrange with the Syracuse Letter Company for mailing announcements was discussed. The Secretary was empowered to make arrangements for this service.

One new member was elected to active membership in this section.

The speaker of the evening was ROBERT M. NORTON, District Manager, Hanson-Van Winkle-Munning Corporation. Moving pictures of the operation of various automatic plating equipment were shown with comments, explanations, and answers to questions.

LIBRARIAN SWARTZ proposed a symposium by the members for the December meeting on the subject of the Effect of Impurities in Electroplating Solutions. This is an outgrowth of a letter from FRANK K. SAVAGE asking us to collect information from our members on the subject. Mr. Swartz suggested D. M. OVERCASH as Chairman for this symposium and a letter will be forwarded by Mr. Swartz outlining the procedure to be followed.

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ROCKFORD BRANCH

The Rockford Branch of the American Electroplaters' Society held its annual membership stag at the Faust Hotel, Friday evening, November 8. The December meeting of the Branch will be held at the Faust Hotel December 9, at which time the Branch will see films showing Automatic Plating Conveyors sold by the Hanson-Van Winkle-Munning Company.

Plans for the annual educational session and banquet are already in progress and reservations have been made to hold this at the Faust Hotel on Saturday, March 28, 1947.

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PHILADELPHIA BRANCH

The Philadelphia Branch met at its old stamping grounds, the Harrison Laboratory of the University of Pennsylvania, October 25, 1946, with PRESIDENT ORLIK in the chair.

Four applications were referred to the Board of Managers. After approval by the Board of Managers, nine new members were elected to membership. There were three suspensions, due to failure to report new addresses.

ALBERT HIRSCH petitioned the Branch to honor OTTO MOTT and JOSEPH E. UNDERWOOD by granting them honorary membership to the Branch; on motion, they were duly elected.

LIBRARIAN HIRSCH started the shop problem hour by introducing DR. R. WICK, who spoke on "Impurities and Purification of Plating Solutions".

Suggestions to the Research Committee—Devise methods for identification of impurity spots on nickel; investigate the effects of impurities in white nickel solutions to expedite the "buffability" of same; devise methods for removing Cu from tin baths; removing lead from brass solutions (introduced through lead in brass anodes); removing lead from gold solutions; removing cadmium from zinc solution (other than zinc dust or plating out); removing germanium from high acid and low acid zinc baths (will stop plating).

So ended a very interesting quiz evening; let's have some more of them!

SECOND VICE-PRESIDENT HEIMAN reported progress on the membership drive (and the results show it).

PAUL MENTZER, SR., *Secretary.*

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DETROIT BRANCH

Over one hundred members and guests attended the November meeting of the Detroit Branch of the American Electroplaters' Society held at the Hotel Statler, Friday evening, November 1. In the absence of our President, WRIGHT W. WILSON, PAUL STRAUSSER handled the meeting in a very capable fashion.

As usual a good number of new members were elected to membership, and there being no further business to transact, the meeting was turned over to GEORGE PILLSBURY, our Librarian, who introduced W. H. HISEY of Goodyear Tire and Rubber Company who spoke to us on "Do We Mean It". Mr. Hisey's talk was completely non-technical, and gave us all plenty of food for

thought on the future of our country. Proof of the thought-provoking features of Mr. Hisey's talk were brought out by the good number of questions which were discussed before the meeting closed.

The lighter side of the meeting consisted of two motion pictures: one entitled "On the Wing", and the other "Pheasant Fever". At the conclusion of the meeting refreshments were served to the enjoyment of all.

R. H. DUDLEY,
Publicity Chairman.

NEW HAVEN BRANCH

New Haven Branch held its monthly meeting October 15, 1946, in the Sterling Chemistry Laboratory, Yale University. A dinner in the Pilgrim Room of the Hotel Duncan preceded this meeting, when the general topic of finishing was discussed.

Technical Chairman C. FRED GURNHAM introduced the speaker, WILLIAM S. WISE, Chief Engineer of the Connecticut State Water Commission. Mr. Wise's subject, "Pollution Abatement and Treatment of Plating Wastes", has always been a problem to every finishing plant, and with new legislation being introduced demanding control of these wastes, an early solution of these problems will be necessary.

The speaker gave his audience a wide picture of the present-day control with an explanation of what will be expected in the future. At the present time the Water Commission has been patiently working on these problems with each individual plant and with the hope of some general research being conducted along these lines at a later date.

At the conclusion of Mr. Wise's talk he generously answered the numerous questions asked of him. The meeting adjourned with the members discussing various types of research which should be contemplated. A rising vote of thanks was given to Mr. Wise for this vitally interesting subject. Meeting adjourned at 11 P. M.

B. J. GAFFNEY, *Secretary.*

DAYTON BRANCH

The Dayton Branch of the American Electroplaters' Society held its regular meeting on November 8, 1946, at the Engineers Club, Dayton, Ohio. Forty-eight members were present. This was a joint meeting with the American Institute of Chemists.

The meeting was called to order by the President, W. E. MOLINE. Mr. Moline called on MR. LUACES to introduce the speaker of the evening, DR. DONALD PRICE, Director of Research of the Oakite Products, Inc. Dr. Price's subject was "The Chemistry of Wetting Agents". He was well informed and gave a very interesting talk on this subject. After the talk Dr. Price answered many questions from members of the audience.

The meeting was adjourned by Mr. Moline and a rising vote of thanks was given Dr. Price for a very enjoyable evening.

RALPH CLINEFELTER,
Secretary and Treasurer.

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We are manufacturers of Fireplace Fixtures and need a trained man to take charge of our Brass Plating Department. Work about 20 men in plating, polishing and buffing. We plate only brass, on cast iron and steel. Expanding this department. Well established company. Located in Middle West. Please state experience and education.

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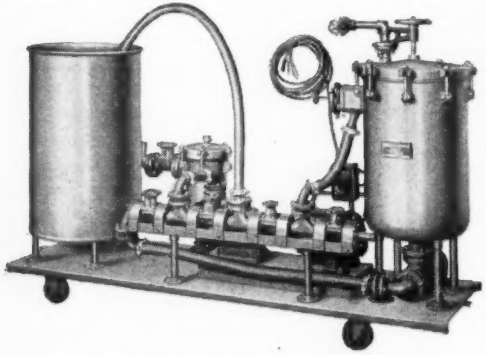

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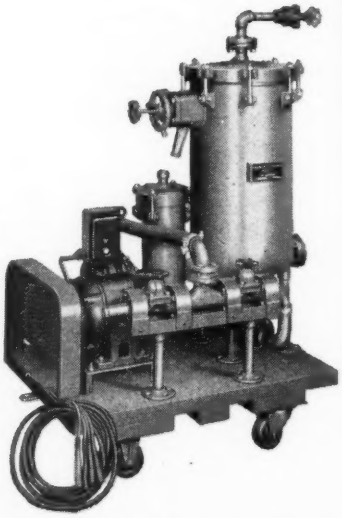

No. 2—A typical portable filter as constructed for bright nickel, acid copper and other acid type bath. Used for either intermittent or continuous filtration.

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By KENNETH M. HUSTON

Chairman, Program and Educational Committee

The Tainton Electro-Galvanizing Process for Brylanised Wire

H. ROEBUCK and A. BRIERLEY. *J. Electrodepositors' Tech. Soc.*, **21**, 91–101 (1946).

This patented process, first installed commercially in 1933 at a Bethlehem Steel Company plant, is thoroughly described, diagrammed, and illustrated. Wire is continuously plated at from 850 to 2,000 asf. The deposit is adherent, smooth, ductile, highly corrosion resistant and of uniform thickness. Physical properties of the wire are not impaired by treatment during the process. The electrolyte is made from, and replenished by, roasted zinc blende ore. Anodes of 1% silver-lead are used. The ore is leached in depleted electrolyte from the plating cells which contain 200 to 250 g/l sulfuric acid.

At the completion of this leach, the acid has been neutralized and iron, aluminum, and other metals are precipitated as hydroxides and filtered out. Zinc dust is then added to cement out copper, cadmium, and some other remaining metals. After another filtration, the solution is fit for use in replenishing the plating bath. Manganese is present, running 5 to 10 g/l. This is converted during plating partially to permanganate and partially to hydrated manganese dioxide, the latter of which is periodically removed from the cells and anodes and subsequently used as an oxidizing agent for iron in the leaching process. The spent electrolyte from the cells is used for anodic cleaning of the wire prior to plating before it is replenished with zinc and purified.

The wire from the supplying rolls is first fed through an annealing bath of molten lead at 730–750° C. In order to avoid oxidation after annealing, it is fed from the lead bath through a reducing atmosphere in a steel trunking, one end of which is submerged in the lead and the other in water. It is then acid cleaned anodically at 80° F and a minimum of 500 asf and fed directly into the plating cells, then water washed, steam dried, and polished by revolving blades tipped with tungsten carbide which leave a polished surface but remove no metal. For checking plate thickness, a rapid gasometric method is used.

LYMAN B. SPERRY.

●

Zircon Porcelain—A Modern Ceramic

RALSTON RUSSELL, JR. *Westinghouse Engineer*, **6**, 90–95 (May 1946).

Its unusual properties—high mechanical strength and thermal shock resistance, low electrical loss, high-temperature electrical resistivity and great moisture resistance—make it almost the ideal ceramic and promise it extensive use.

Shop Problems—Finishing Stainless Steel

ANON. *Metal Finishing*, **44**, 252 (June 1946).

A question on the finishing of stainless steel is asked and answered:

Question: We are interested in improving our quality on stainless steel mirror finishing. Can you aid us by your recommendations as to (1) Polishing: A—Grain Size of Emery; B—Wheel Material (felt, leather, etc.); C—Wheel Speed; D—Lubricants. (2) Buffing: A—Buff Type; B—Composition; C—Speed or sfpm.

Answer: The grain size of emery as well as the wheel material will depend on the original condition and shape of the article; 6,000 to 8,000 ft. per minute is recommended as a wheel speed for polishing with the application of tallow grease stick.

For buffing, a sewed or pocket type buff is used. Aluminum oxide rouge should be used for cutting and either chromic oxide or aluminum oxide for coloring. The wheel speed should be 9,000 to 10,000 ft. per minute.

●

Passivation of Zinc Using Dichromate Base Solutions, with Special Reference to Electrodeposits

E. E. HALLS, *Metallurgia*, **32**, 99–104 (1945); *Chem. Abstracts*, **40**, 2425 (1946).

Proprietary processes employ chromate-sulfuric acid solutions containing inhibitors to reduce the attack on zinc to a minimum and oxidizing agents to keep chromium oxidized. In salt spray test, in 100% humidity test at 140° F and in milder humidity tests, the results were better when proprietary solutions had been used than straight chromate-sulfuric acid solution. Chromic acid alone had little value. No difference was noted in results between deposits from cyanide and sulfate electrolytes. The average thickness of the zinc should never be less than 0.0003 in. and the thinnest area never less than 0.0002 in. When paint or enamel is applied over the chromatized surface, little improvement is noted.

ERNEST H. LYONS, JR.

●

Polarographic Determination of Zinc in Nickel Sulfate and Nickel Baths

D. A. VYAKHIREV. *Zavodskaya Lab.*, **11**, 641–644 (1945); *Chem. Abstracts*, **40**, 2749 (1946).

Zinc is precipitated as the sulfide from the nickel solution. The sulfide is dissolved in HCl and neutralized with NH_4OH, and an ammonium acetate-potassium thiocyanate solution is added. The solution is electrolyzed with the polarograph which gives the amount of zinc immediately. The method is more accurate and faster than the gravimetric method, but the separation of zinc from nickel requires considerably more time than the determination of the zinc.

ERNEST H. LYONS, JR.

●

Bismuth Electroplating

A. I. LEVIN. *J. Applied Chem.* (U. S. S. R.) **17**, 613–618 (1944); *Chem. Abstracts*, **40**, 2075 (1946).

Good electrodeposits of bismuth on steel were obtained from baths containing 70 to 100 g/l $NaBiCl_4$ and 200 to 300 cc/l concentrated HCl. A small amount of glue improved the throwing power and gave shiny, decorative deposits.

ERNEST H. LYONS, JR.

●

Continuous Production—Metal Cleaning; Dip Coating; Baking

GILBERT C. CLOSE. *Industrial Finishing*, **22**, 60–63 (May 1946).

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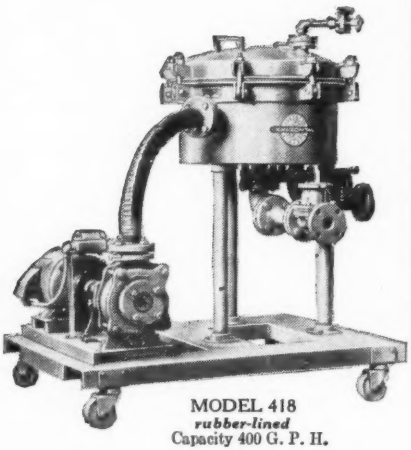

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By GEORGE B. HOGABOOM

Consultant, New Britian, Conn.

No. 2,407,579, September 10, 1946—Electrodeposition of Tin—Ernest W. Schweikher, assignor to E. I. du Pont de Nemours & Company.

It is an object of this invention to provide compositions, baths and processes by the use of which there may be obtained tin deposits which are adherent and of good appearance.

Another object is to provide acid tin-plating baths which produce deposits that may be readily brightened by fusion to a brilliant appearance and that will not discolor after heating operations. It is a still further object to provide tin-plating baths which are readily amenable to improvement by the use of common addition agents for tin-plating baths.

The foregoing and other objects of this invention are attained by the use of an alkali fluoride-stannous chloride bath in which the ration of fluoride to stannous chloride is carefully selected and related to the operating *p*H of the bath and in which the equilibrium potential of the bath is held within certain limits. Baths of this invention are readily amenable to improvement by the inclusion of addition agents and it will usually be found desirable to include one or more organic addition agents.

Fluoride-stannous chloride baths used according to the present invention may be made up with stannous chloride and with an alkali fluoride, say sodium, potassium or ammonium fluoride, or a bifluoride may be used or mixtures of any two or more of these may be used.

(NOTE. The composition of 12 baths is given, among them the following.)
Number XII—A bath for the electrodeposition of tin on strip steel subsequently to be flow or fusion brightened was prepared as follows:

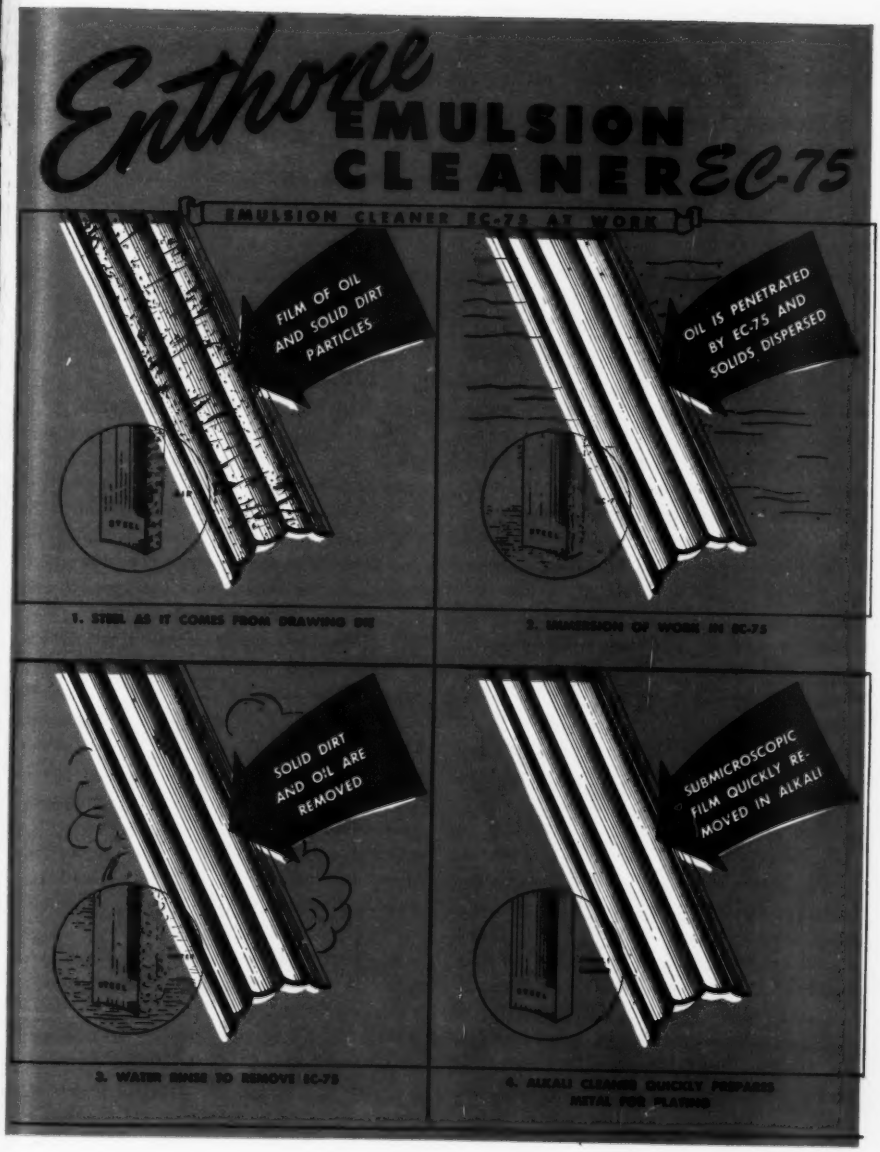
	Grams/l	Gram mols/l
Stannous chloride	75	0.33
Sodium fluoride	40	0.95
Sodium bifluoride	35	0.56
Beta-napthol ethylene oxide	0.1	....

Temperature 135°F

CLAIM 1. A tin electrodepositing composition comprising an alkali fluoride and stannous chloride, the composition upon being dissolved in water to give a stannous chloride concentration of between 37.5 and 150 grams per liter satisfying the equation:

$$pH = \frac{k(\text{mols MF})}{\text{mols } SnCl_2}$$

wherein the following conditions are simultaneously true: the *p*H is equal to about 1 to 5, k has a value from 0.1 to 1.0, MF is alkali fluoride, and the mol ratio $MF/SnCl_2$ is about 2-12, the static potential of the tin in the bath being equal in volts from $-(0.055pH-0.265)$ to $-(0.055pH-0.370)$.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EMULSION CLEANER EC-75 AT WORK
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BOOK REVIEWS

By DR. HAROLD J. READ
Associate Professor of Metallurgy
The Pennsylvania State College

WATER TREATMENT AND PURIFICATION, by William J. Ryan, Second edition, 1946, IX+270 pages. McGraw-Hill Book Company, Inc., New York City. Price, $2.75.

In recent years the practical electroplater has become increasingly aware that the water used in compounding his cleaning and plating solutions, is as truly a chemical as his acids, bases and salts, and that as such, its purity is a matter of more than a little consequence. The detrimental effects which can arise through the presence in the plating room solutions of small amounts of certain impurities have been emphasized again and again, particularly in reference to high-speed and bright plating processes. It is self-evident, therefore, that the practical plater should know what impurities are likely to be found in water, how to detect their presence and determine their quantity, and, finally, how to remove harmful constituents.

Until a specialized treatise is written to more exactly fill the needs of the plater, he will have to rely on texts devoted to the general problem of water treatment and purification. Of these the book by Mr. Ryan is a reasonably satisfactory example. He has presented the subject in a clear, easily readable style, and supplemented his descriptive material with numerous line drawings and photographs. An elementary knowledge of simple inorganic chemistry on the part of the reader has been presupposed, but no background of physical chemistry or chemical engineering will be needed to utilize this book. A rather considerable portion of the volume does not relate directly to operations which are likely to be encountered in the plating plants (and nothing at all is said specifically about plating solutions), but this will be true of any general text on water treatment. In this case one suspects that many readers will find the book so interesting and so well written that they will read all or most of it.

The first chapter describes the impurities which may be found in water, and it is unfortunate that more space was not devoted to this subject. After two chapters on sedimentation, coagulation and filtration, the objectives of water analysis are described. Procedures for the various analyses are not given. This is in line with the rest of the book where principles rather than details are emphasized. The following chapter on the lime and soda-ash process is particularly well-done. The discussion of ion exchangers, which appear to offer attractive possibilities to the plater, is reasonably adequate even though the author is concerned primarily with their use in the softening of water rather than in the removal of impurities. More information on the use of acid absorbent materials for the removal of anions would have been desirable.

The remainder of the volume is devoted to boiler feed-water treatment, disinfection of water, tastes and odors, miscellaneous treatments (including the removal of iron and manganese) and the prevention of corrosion. The latter chapter of only fourteen pages contains a surprisingly large amount of information. The corrosion experts may quarrel with the author's simplified treatment of the theoretical aspects of corrosion, but his explanations are adequate for the purposes of this book.

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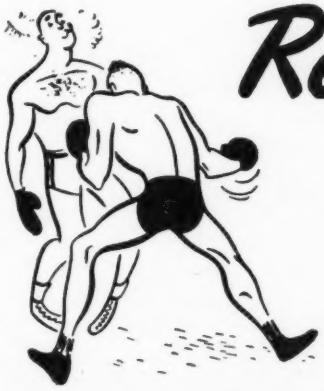

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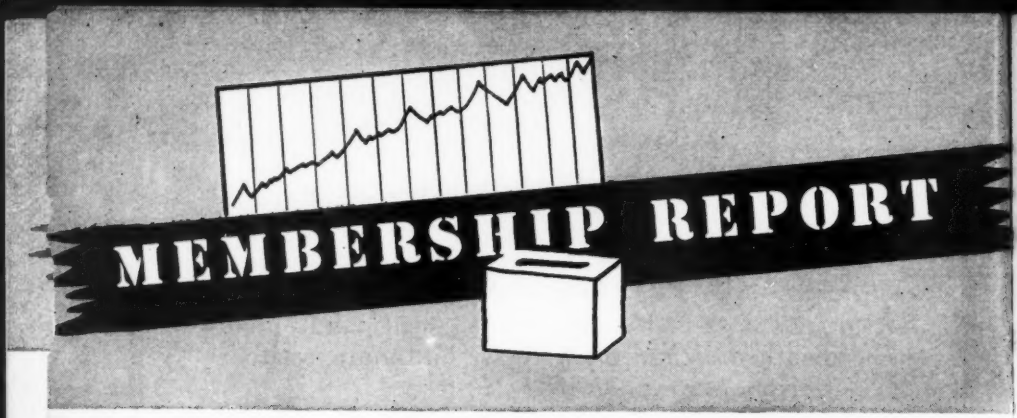

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CHICAGO	359	+14½	+ 4.0
TORONTO	131	+ 5	+ 3.8
HARTFORD	134	+ 3½	+ 2.6
CLEVELAND	177	+ 4½	+ 2.5
LOS ANGELES	181	+ 4½	+ 2.5
BOSTON	168	+ 2½	+ 1.5
WATERBURY	128	.....	.....
NEWARK	243	− 8	− 3.3
DETROIT	440	−32½	− 7.4
SECOND GROUP			
INDIANAPOLIS	90	+12	+13.3
PITTSBURGH	97	+ 8	+ 8.2
ST. LOUIS	122	+ 9	+ 7.4
DAYTON	87	+ 4	+ 4.6
PROV.-ATTLEBORO	122	+ 5	+ 4.1
BUFFALO	87	+ 3½	+ 4.0
SPRINGFIELD	82	.....	.....
BALTIMORE-WASH.	114	.....	.....
GRAND RAPIDS	116	.....	.....
ROCHESTER	197	− 1	− 1.0
SYDNEY	82	− 1	− 1.2
MILWAUKEE	120	− 3	− 2.5
NEW HAVEN	110	− 3½	− 3.2
JACKSON-LANSING	85	−32½	−38.2
THIRD GROUP			
ADELAIDE	37	+12	+32.5
ROCKFORD	53	+ 9	+17.0
SYRACUSE	64	+ 6	+ 9.4
SAN FRANCISCO	64	+ 5	+ 7.8
ST. JOSEPH VALLEY	60	+ 4½	+ 7.5
TWIN CITY	72	+ 4½	+ 6.3
COLUMBUS	34	+ 2	+ 5.9
MELBOURNE	59	+ 1	+ 1.7
TOLEDO	60	− ½	− 0.8
CINCINNATI	58	− ½	− 0.9
LANCASTER	38	− 1	− 2.6
MONTREAL	61	− 3½	− 5.8

Membership May 1, 1946: 4,527
Membership Nov. 15, 1946: 4,640

Gain in Membership: 113
Per cent Gain: 2.5

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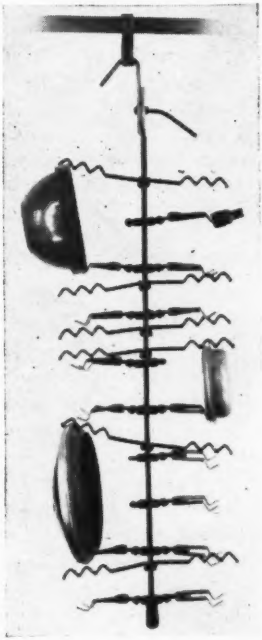

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Teflon, Newest Plastic, Introduced by Du Pont

"*Teflon*" tetrafluoroethylene resin, the new *Du Pont* plastic which is unharmed by temperatures up to 575° F and withstands every known solvent, is described as the answer to many long-standing problems in the electrical equipment field.

Surpassing polystyrene and polythene, both with favorable electrical properties, "*Teflon*" has an extremely low dielectric loss factor, even at frequencies up to 3,000 megacycles. Thus it is an excellent insulating material for the ultra-high frequencies required by radar and television. It does not dissipate the electrical power as do most organic insulators when subjected to high-frequency currents.

Films of "*Teflon*" may be flexed without cracking at temperatures as low as 100° C, and its water absorption rate is rated "zero". High impact strength and toughness are among its other properties.

In addition to its promising future in the electrical field, "*Teflon*" is now widely used as a gasket material when resistance to heat or corrosion is required. It is being used for diaphragms for pumps and valves, and as a packing material for valves.

●

J. C. Miller Introduces New Product, Liquimatic

The *J. C. Miller Company* of Grand Rapids, Mich., has recently introduced to the metal finishing industry, a new product—*Liquimatic*—a liquid buffing compound.

This compound, it is reported, effects notable savings in both compositions and buffs and incorporates many safety and production-building features not found in average compounds.

A descriptive bulletin, fully discussing the advantages of *Liquimatic*, is available from the manufacturer, 55 Mt. Vernon N. W., Grand Rapids 4, Mich.

●

Enthone Introduces New Emulsion Cleaner EC-75

A four-page bulletin has been issued by *Enthone, Inc.*, 442 Elm Street, New Haven, Conn., describing a new emulsifiable emulsion cleaner claimed to be safe for use in the plating room to act as a precleaner on all types of metals.

Designated as *Emulsion Cleaner EC-75*, this product is recommended for the removal of oil, buffing compounds and other organic dirt, as well as solid dirt, from all types of metals including active metals such as zinc, aluminum, brass and nickel silver. One of the outstanding features of this

product is that it is said to be unharmful to cleaners when it is dragged into them, and it is claimed to actually increase the cleaning ability of alkali cleaners.

Emulsion Cleaner EC-75 is used undiluted. The material is a penetrating solvent to replace naphtha, kerosene and chlorinated solvents and, in addition, it has high detergency and emulsifiability.

The manufacturer will be glad to furnish literature upon request.

●

H-VM-M Expands Personnel

The *Hanson-Van Winkle-Munning Company,* Matawan, N. J., has announced a number of additions to and changes in its technical, sales and service staffs. The increased personnel will aid the Company in providing wider and better service to its customers.

Paul J. Lalonde has been transferred from chemical research activities to engineering service and development for the electrotypers' and stereotypers' industry. He is a graduate of Rensselaer Polytechnic Institute with a degree of Ch.E. and has had wide experience as a member of the technical staff of the Hanson-Van Winkle-Munning Company.

Dr. Otto Kardos has been assigned to the post of Research Electrochemist for the study of plating solutions. Dr. Kardos received his Ph.D. in Chemistry from the University of Vienna and served for a number of years as chief chemist of Galvapol in that city. Later he was engaged in the chemical and electrochemical fields in France and the United States, prior to joining the H-VW-M organization.

D. Gardner Foulke has joined the H-VM-M technical staff as a process electrochemist. Dr. Foulke received his B.S. in Chemistry at Juniata College and an M.S. and Ph.D. at Rutgers University. Until recently he was director of the Analytic Laboratory of Foster D. Snell, Inc. He had previously had wide experience in the chemical and electrochemical fields. He is a member of the American Electroplaters' Society, the Electrochemical Society, the American Society for Metals, the A. S. T. M. and the American Chemical Society.

Flat Conveyor Spray Washer Announced by Optimus Company

A flat conveyor type, spray-washing machine, adaptable for cleaning and similar spray operations, as well as for drying, has been announced by the *Optimus Equipment Company*, 131 Church Street, Matawan, N. J., manufacturers of metal washing and drying equipment.

The new machine will rapidly spray any parts which may be handled either in baskets, on racks, or simply laid on the conveyor.

The manufacturer states this type of conveyor can be adapted to many different and difficult problems. Special parts can be positioned if necessary, and little labor is required for loading or servicing.

Alkaline, acid, solvent type, air drying, oil spray, and many similar operations can all be handled. Any type of heating can be employed, and machine is available in all sizes with any variety of horizontal conveyor.

The machine features a long horizontal tunnel placed on top of a series of solution tanks. A continuous flat conveyor runs the length of the tunnel, carrying parts through a series of operations.

Solutions are forced on the parts through a battery of spray nozzles by means of a powerful pump. Machine is self-contained, but it may be connected to any other conveyor-moved operation, thus reducing parts handling to a minimum.

•

N. A. C. E. Names A. B. Campbell Executive Secretary

A. B. Campbell, formerly Eastern Representative of Hughes Brothers, has accepted the position of Executive Secretary of the *National Association of Corrosion Engineers*, with headquarters in Houston, Texas.

Mr. Campbell is a graduate in Electrical Engineering of the University of Illinois and also has the professional degree of Electrical Engineer from that school. From 1915 to 1920 he was on the faculty of the Engineering Extension Department of Iowa State

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Simple test sets for aid in controlling plating and other solutions.

Write for literature.

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Specify Kocour Sets from your supplier.

College. From 1920 to 1923 he served as electrical engineer on the Iowa Board of Railroad Commissioners. He was an engineer on the headquarters staff of the N. E. L. A. and the E. E. I. from 1923 to 1943, at which time he joined Hughes Brothers. The new executive secretary is a fellow of the A. I. E. E.

•

Du Pont Issues Booklet on Color Conditioning

Du Pont Color Conditioning for Industry, a new 32-page booklet illustrated in full color, is available on request to the Finishes Division, Dept. M-6, Wilmington 98, Del.

Illustrating and describing years of research and practical experience with color to increase production, improve seeing conditions and create a better working environment, the booklet makes clear the fundamental principles on which color conditioning is based.

The "Three-Dimensional Seeing" treatment of machines is depicted with photographs of actual installations. The Safety Color Code for Industry is also outlined. Color conditioning is shown at work in plants of several well-known companies. A coordinated functional color program for an entire plant is illustrated in a double-page cutaway drawing.

•

Zialite in New Location

The *Zialite Corporation* has announced a new location for its office and factory as of November 1. The new address is 92 Grove Street, Worcester 5, Mass.

Larger and better manufacturing facilities will enable the company to meet its stepped-up production schedule with greater ease and to offer its customers greater service.

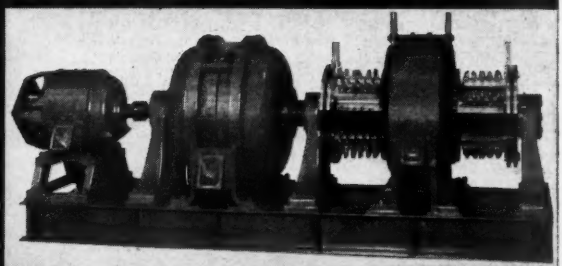
•

Claud S. Gordon Company Issues Bulletin on Xactline

A 4-page bulletin, giving a complete technical description of *Xactline Straight Line Temperature Control Instrument* has been issued by the *Claud S. Gordon Company*, 3000 S. Wallace Street, Chicago 16, Illinois.

Xactline provides new standards of accuracy, holding tolerances as close as 1/5 of a degree F and on-off cycles as short as

COLUMBIA MOTOR GENERATORS



FOR ELECTRO-PLATING

Columbia Generators embody every feature essential for dependable, 24-hour operation. They are built for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes, for anodic treatment of aluminum in sizes of 40, 50, and 60 volts, 500 to 3,000 amperes. Columbia Generators for other electrolytic processes range from ½ to 250 KW, 100 to 40,000 amperes, 6 to 60 volts. Write for full information.

COLUMBIA ELECTRIC MFG. CO.
4519 HAMILTON AVE., N.E. CLEVELAND 14, OHIO

three seconds have been attained. One model serves all applications. Suitable for ovens, furnaces, melting baths, etc., wherever a thermocouple can be used.

●

Bakelite Corporation Offers Special Illustrated Lecture

Plastics in Our World Today is the theme of a special lecture, illustrated by slides and demonstrations, presented by *Bakelite Corporation*.

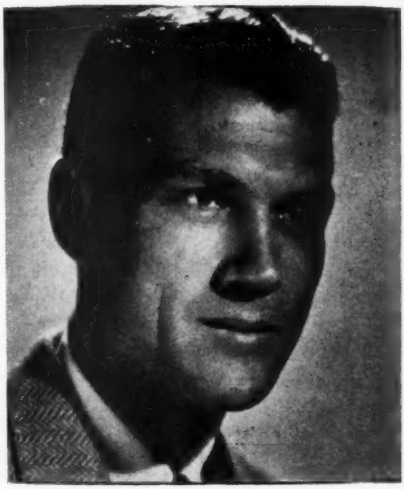
Without cost, Bakelite Corporation offers this program to leading industrial and civic organizations, trade associations, and educational groups.

Due to the size of the display, the presentation is limited to relatively large audiences. As there is only one unit in operation, requests for booking should be made well in advance so that a definite itinerary can be followed.

Further information can be obtained from Consumer Relations Division, Bakelite Corporation, 300 Madison Avenue, New York, 17, N. Y.

Eugene C. Bosl Appointed H-VW-M Sales Representative

The *Hanson-Van Winkle-Munning Company* has announced the appointment of



Eugene C. Bosl as a Sales Representative. He is now located in the Milwaukee office

FOR SALE Available for Immediate Shipment

THE FOLLOWING EXCELLENT USED AND REBUILT ELECTROPLATING MOTOR GENERATOR SETS, WITH FULL CONTROL EQUIPMENT:

2—15,000/7500 AMPERE, 6/12 VOLT, **COLUMBIA,**
3—5000/2500 AMPERE, 6/12 VOLT, **COLUMBIA,**
1—5000/2500 AMPERE, 6/12 VOLT, **EAGER,**
1—4000/2000 AMPERE, 3/6 VOLT, **HANSON-VAN WINKLE,**
1—3000/1500 AMPERE, 6/12 VOLT, **BENNETT & O'CONNELL,**
1—2500/1250 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE,**
1—2000/1000 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE-MUNNING,**
1—2000/1000 AMPERE, 10/20 VOLT, **CHANDEYSSON,** 25° UNIT,
1—1500/750 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE,**
1—1000/500 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE,**
4—1000/500 AMPERE, 6/12 VOLT, **CHARLES J. BOGUE,**
1—500 AMPERE, 6 VOLT, **HANSON-VAN WINKLE,**
1—300 AMPERE, 6 VOLT, **HANSON-VAN WINKLE,**
1—200 AMPERE, 7½ VOLT, **HOBART,**
1—200 AMPERE, 7½ VOLT, **CHANDEYSSON,**
1—150 AMPERE, 7½ VOLT, **HOBART,**
2—125 AMPERE, 15 VOLT, **KIMBLE,**
1—125 AMPERE, 7½ VOLT, **CHANDEYSSON,**
1—100 AMPERE, 7½ VOLT, **WEIDENHOFF.**

ANODIZING MOTOR GENERATOR SETS:

1—1000 AMPERE, 50 VOLT, **CHANDEYSSON,** Synchronous motor,
1—500 AMPERE, 24 VOLT, **HANSON-VAN WINKLE,**
1—**HANSON-VAN WINKLE-MUNNING CO.** SEMI-AUTOMATIC CONVEYOR OUTFIT—PRACTICALLY NEW—For Cyanide Plating—24 ft. x 4 ft. x 3 ft.
1—**MEAKER** SEMI-AUTOMATIC CONVEYOR UNIT—For Cyanide Plating. Excellent Condition. 20 ft. x 3½ ft. x 4 ft.

M. E. BAKER COMPANY 143 SIDNEY STREET CAMBRIDGE, MASS.

of the Company, after an intensive training program at Matawan.

Mr. Bosl is a graduate of the Milwaukee State Teachers College, with the degree of Bachelor of Education in Chemistry. Prior to coming with the Hanson-Van Winkle-Munning Company, Mr. Bosl served as a Lieutenant in the U. S. Navy and before the war he was an instructor in chemistry at the Milwaukee Vocational School.

●

Amercoat Issues Bulletin on Protecive Coating

A comprehensive 8-page technical bulletin, streamlined for ready reference, giving factual information in condensed form about the entire Amercoat line, has been issued by the *Amercoat Division, American Pipe and Construction Company.*

Chart shows all characteristics and properties of Amercoat plastic coatings. Also, it is a ready guide for selecting the proper coating, preparation of the surface, and application methods on steel, concrete and wood. In addition, cost per square foot for materials, with area formulae, is provided.

A copy of this chart will be sent free on request. Write Amercoat Division, American Pipe and Construction Company, P. O. Box 3428, Terminal Annex, Los Angeles 54, Calif.

●

Kerr Releases Catalogues on Industrial Precision Casting

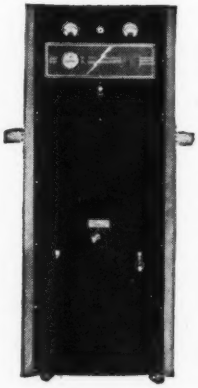
Two catalogues, *Fundamentals of Precision Casting* and *Precision Casting Equipment and Materials* have just been released by the *Kerr Manufacturing Company,* 6081 12th Street, Detroit 8, Mich.

The first booklet traces the origin of the "lost wax method" as employed by the Chinese over 2,000 years ago and the modern application of this method to the field of industrial precision casting.

The second booklet illustrates and describes the specialized materials and equipment necessary to achieve the close tolerances demanded by present-day industry for volume production.

The purpose of these publications is to encourage designers and engineers to explore and plan for the great possibilities of industrial precision casting in future manufacturing procedures.

Speed Up and Improve ELECTROPLATING *with the* R-A SELENIUM RECTIFIER



9 volts—2000 amperes
9 volts—1500 amperes
9 volts—1000 amperes
9 volts— 500 amperes
18/9 volts—500/1000 amperes
6 volts—2000 amperes
6 volts—1500 amperes
6 volts—1000 amperes
6 volts— 500 amperes
12/6 volts—500/1000 amperes

Make your selection of these completely self-contained Selenium Rectifiers with meters, off-on switch and stepless variable control. Standard units can be used in multiple arrangements to obtain 5000 and 10,000 amperes or higher.

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Rectifier Divison

RICHARDSON-ALLEN CORPORATION

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Shown on flat car, one hundredth fully automatic plating machine shipped out of The Udylite Corporation.

District Engineers Appointed by Torrington Company

The *Torrington Company*, Torrington Conn., and South Bend, Ind., has announced the following District Engineer appointments in connection with the company's anti-friction bearing activities: Chicago, Ill., *Frank H. Marchand*, District Manager; *Ray G. O'Connell* and *C. R. Recor*, District Engineers. At Torrington, Conn., Cincinnati, Ohio, and Los Angeles, Calif., new District Engineers are, respectively, *Buell D. Dean*, *Fred J. Norman* and *Frank B. Tipton*.

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Quality and Uniformity at All Times

Buffing and Polishing Compounds that Increase Production

Try our cement and thinner instead of glue ready for use—no cooking—use abrasive cold.

Write us about any special problems you may have. We will be glad to help you solve them, and will send samples of any of the compounds we manufacture for Cutting, Cut & Color, and Mirror Finishing.

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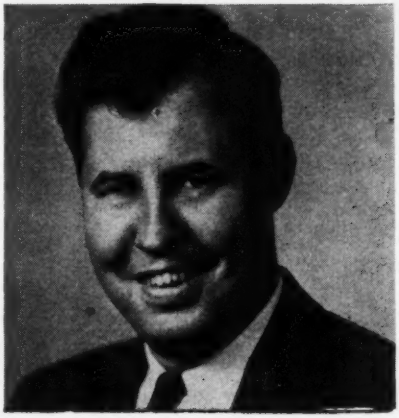
Haverhill, Mass.



EDWARD

Twins Serve Same Industry

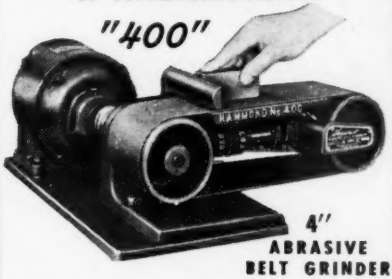
Edward F. and *Edwin A. Stack* are twins, born in Chicago in 1913, graduated in Chemical Engineering from Notre Dame in the class of '39 and now both are serving the same industry.

Edward is Technical Sales Representative for *MacDermid* in the Chicago territory, while *Edwin*, after being released from the Army, has joined the *Udylite* organization and also is serving in the Chicago area.

Both are members of the *American Society for Metals* and the *American Electroplaters' Society.*

EDWIN

Hammond
of KALAMAZOO
"400"



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TANKS
For Cleaning, Pickling and Plating

● For 39 years leading manufacturers have relied on Kirk & Blum for custom-built tanks to meet their individual production requirements.

We are equipped to fabricate tanks of Steel, Lead or Rubber Lined, Monel Metal, Stainless Steel, Copper, Aluminum, Inconel, etc.

Tanks are supplied with or without exhaust ducts and fans as conditions or specifications indicate.

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The KIRK & BLUM Mfg. Co.
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Zinc-Brite

TRADE MARK REG'D.

spells EFFICIENCY—
ECONOMY

Improves appearance of, and brightens your zinc deposit by removing heavy metal impurities from cyanide zinc plating solutions.

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PROGRESSIVELY BETTER
ABRASIVE COMPOUNDS

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Manufacturers
BUFFING COMPOSITIONS
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Best's Safety Directory

The *Alfred M. Best Company* announces, through its Safety Engineering Division that the first annual edition of Best's Safety Directory—the first complete reference volume of all known safety products—is now off the press and ready for distribution.

For the first time in one volume, this directory presents to management, safety directors, purchasing agents, plant superintendents and industrial medical personnel an "encyclopedia" covering essential information on over 1,000 products, devices and equipment used in safety, first-aid, hygiene, health conservation and fire protection.

By telling in a nutshell "what safety product to use," "when to use it," "how to use it," and "where to get it," Best's Safety Directory helps to prevent accidents, decrease production costs and eliminate time and energy normally wasted when writing, 'phoning, or 'hunting around' for safety information by

1—Listing all safety products and all the latest improvements.
2—Describing the hazard and the "remedy".
3—Pointing up the need and field of use of each product.
4—Giving the names and addresses of manufacturers, distributors and local dealers.

It is cross-indexed and contains a comprehensive, topical index which makes for easy use.

The price is $5.00 and it can be obtained from the home office of the Alfred M. Best Company, 75 Fulton Street, New York City 7, or at any of its branch offices located in Atlanta, Boston, Chicago, Cincinnati, Dallas or Los Angeles.

•

Pickling and Washing Machine Introduced by Goodrich

A four-page broadside on its recently introduced spray-type pickling and washing machine has just been published by *The B. F. Goodrich Company*, Akron, Ohio.

The broadside recites the advantages of the machine's operation over the old type dip method of pickling and washing, and illustrates with sketches each of these. The

machine, lined with rubber by the company's famous *Vulcalock* process, is individually engineered for each specific operation.

●

Allegheny Ludlum Steel Offers Two Motion Pictures

For the first time in the history of steel making, the vivid changes occurring during a heat within the walls of an electric arc furnace now may be seen in actual colors through the eyes of the motion picture camera.

A dramatic, 15-minute picture story entitled "*Melting of Huron Die Steel*", produced for the *Allegheny Ludlum Steel Corporation* at its Dunkirk, N. Y., plant, graphically reveals what the human eye never has been able to observe—the true color of the molten steel and slag.

Slag covering the molten steel is first shown, followed by shots of the true color of the steel itself as the slag is broken apart. Animated diagrams describe the melting process from the moment the scrap is placed in the furnace until the pure stainless steel is poured into the ladle.

"*Melting of Huron Die Steel*" is available free of charge for technical and lay audiences. It also is the first of a series that will tell the story of tool steel from its beginning through to the finished product.

Another new Allegheny Ludlum film, also available for free showings, is entitled "*Corrosion*" and contains an explanation of the mechanism of corrosive attack and the development of stainless steels.

●

Engineering Company Consolidates

On October 2, 1946, the business of *Eastern Engineering Company* was consolidated with *Automatic Signal Corporation* of East Norwalk, Conn., and taken over by a consolidated corporation, *Eastern Industries, Incorporated.*

The consolidated company has much greater manufacturing, sales and financial facilities than *Eastern Engineering Company* had, and it is anticipated that a material increase in operations will result. Substantially the same personnel will be in charge of operations.

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BACKSTANDS
CONVERT
GRINDERS-POLISHERS
into high production
ABRASIVE BELT UNITS

Hammond Variable Speed Polishing Lathe and No. 3 Backstand installation.

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LININGS AND MORTARS

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CONSTRUCTION

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Buffs—Cleaners
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●

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PERMAG

for preparing metal surfaces prior to finishing

PERMAG Cleaning Compounds are solving the tough cleaning problems on metal surfaces quickly and easily.

Electroplaters find many advantages with PERMAG—time is saved, cost is reduced and better work is done.

Our Service Technicians will be glad to aid whenever you have an extra difficult problem.

Write or 'phone.

Magnuson Products Corp.

Mfrs. Specialized Cleaning Compounds

50 Court St. Brooklyn 2, N. Y.

In Canada: Canadian PERMAG Products Ltd.
Montreal, Toronto

C. R. Dobson Elected to V-P Berth at H. K. Porter Company

H. K. Porter Company, Inc., has announced the election of *C. R. Dobson* as Vice-President in Charge of Operation.

Mr. Dobson, formerly Chief Industrial Engineer of the Jones & Laughlin Steel Corporation, will supervise operations of the seven Porter manufacturing plants.

●

Myron Norman Appointed to Butcher Company Post

The *L. H. Butcher Company* announces the appointment of *Myron Norman* to the staff of the Metal Plating and Polishing Division in its Los Angeles office.

Mr. Norman is a graduate of the Massachusetts Institute of Technology of '39 with a Bachelor of Science degree in Electro Chemical Engineering. Following his graduation he became associated with the Aerovox Corporation as assistant to the Electro Chemical Engineer.

For the six years immediately prior to his connection with the L. H. Butcher Company, Mr. Norman was actively engaged with the Navy Department in Electronic Engineering on the east coast. In addition, he later became Project Engineer in charge of certain phases of the development and production of infrared signalling and detection equipment extending from the Research and Laboratory stages to metal finishing in the final production.

BRANCH DIRECTORY
and
A. E. S. OFFICERS

President.....F. K. SAVAGE
The Kuehne Manufacturing Company, Mattoon, Ill.
First Vice-President.....K. M. HUSTON
3208 Tyndale Avenue, Baltimore, Md.
Second Vice-President.....SAM S. JOHNSTON
Weirton Steel Company, Weirton, W. Va.
Third Vice-President.....ARTHUR W. LOGOZZO
184 South Main Street, W. Hartford 7, Conn.
Past President.....W. L. PINNER
Houdaille-Hershey Corporation, Detroit 11, Mich.
Executive Secretary.....A. K. GRAHAM
P. O. Box 168, Jenkintown, Pa.

ADELAIDE, AUSTRALIA. Acting Secretary G. N. Dixon, G. P. O. Box 428D, Adelaide, Australia.

BALTIMORE-WASHINGTON meets first Tuesday of each month, in October, December, February and April at the Engineers' Club, Baltimore, Md, and in November, January, March and May at Kenesaw Apts, Washington, D. C. Secretary-Treasurer, L. G. Tubbs, 7011 Kenleigh Road., Baltimore 12, Md.

BOSTON meets first Thursday each month at Hotel Statler, Boston, Mass. Secretary, Dr. George P. Swift, 53 Galen St., Watertown 72, Mass.

BRIDGEPORT meets first and third Friday of each month at Barnum Hotel. Secretary-Treasurer, Joseph G. Sterling, 134 Colony Street, Bridgeport 8, Conn.

BUFFALO meets second Friday of each month at Hotel Statler, Buffalo, N. Y. Secretary, J. A. Kushner, 316 Winslow Avenue, Buffalo 11, N. Y.

CHICAGO meets second Friday of each month at 8 P. M., at Atlantic Hotel. Secretary, M. H. Longfield, 1528 S. 61st Avenue, Cicero 50, Ill.

CINCINNATI meets on fourth Wednesday of each month at 8 P. M., at the Engineering Society Headquarters, McMillan Street and Woodburn Avenue, Cincinnati, Ohio. Secretary-Treasurer, Charles Nuzum, 1240 Amanda Place, Cincinnati 5, Ohio.

CLEVELAND meets first Friday of each month in Cleveland Hotel, at 8 P. M. Secretary-Treasurer, George B. Svenson, 2059 Hamilton Ave., Cleveland 14, Ohio.

COLUMBUS meets first Friday of each month at the Battelle Memorial Institute Auditorium, 505 King Avenue, Columbus 1, Ohio, at 8 P. M. Secretary, John G. Beach, Battelle Memorial Institute, Columbus 1, Ohio.

DAYTON meets second Friday of each month at the Engineers Club, Dayton, Ohio. Secretary-Treasurer, Ralph L. Clinefelter, 365 W. Hayes St., West Milton, Ohio.

DETROIT meets the first Friday of each month at the Hotel Statler. Secretary-Treasurer, F. L. Clifton, 16536 Inverness, Detroit 21, Mich.

GRAND RAPIDS meets second Friday of each month, 7:30 P. M., at the Rowe Hotel. Secretary, R. Perkins, 916 Fairmount Street, S. E., Grand Rapids 6, Mich.

HARTFORD meets third Monday of each month at Hotel Bond, Hartford, Conn. Secretary, F. W. Smith, 46 Cottage Street, Meriden, Conn.

BRANCH DIRECTORY

(*Continued from preceding page*)

INDIANAPOLIS meets first Wednesday of each month at Fox Steak House, 1207 Washington Street. Secretary-Treasurer, Carl Niehaus, 937 N. Capitol Ave., Indianapolis, Ind.

JACKSON-LANSING meets second Tuesday of each month at the Home Dairy Co. in Lansing. Secretary-Treasurer, U. J. Forsyth, 1816 Ada St., Lansing 10, Mich.

LANCASTER meets second Friday of each month at 8 P. M., at Thaddeus Stevens Industrial School, Lancaster, Pa. Secretary-Treasurer, H. Clay Brubaker, 881 Manor Street, Lancaster, Pa.

LOS ANGELES meets second Monday of each month, at 6:30 P. M., at Hotel Cabrillo, 11th and Broadway. Secretary-Treasurer, E. R. Holman, P. O. Box 2649, Terminal Annex, Los Angeles 54, Calif.

MELBOURNE, AUSTRALIA. Secretary, L. A. Francis, G. P. O. Box 4502.

MILWAUKEE meets first Friday of each month at the Red Arrow Club, 774 N. Broadway. Secretary-Treasurer, James Durnford, 2370 N. 32nd Street, Milwaukee 10, Wis.

MONTREAL meets first Tuesday of each month at Mount Royal Hotel, Montreal, Quebec, Canada. Secretary-Treasurer, William L. Glover, 754 Second Avenue, Verdun 19, Quebec, Canada.

NEWARK meets first and third Friday of each month at Hotel Robert Treat, Newark, N. J., at 8 P. M. Secretary-Treasurer, George Wagner, 1130 S. Long Avenue, Hillside, N. J.

NEW HAVEN meets second Tuesday of each month alternating between Sterling Chemistry Laboratory, Yale University, and Hotel Taft. Secretary-Treasurer, B. J. Gaffney, 40 Filbert Street, Spring Glen, Hamden 14, Conn.

NEW YORK meets second and fourth Fridays of each month, in the Hotel Pennsylvania, 7th Avenue and 33rd Street, New York, N. Y. Secretary-Treasurer, Franklyn MacStoker, 25 Princeton Street, Garden City, L. I., N. Y.

PHILADELPHIA meets fourth Friday of each month, in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Streets. Secretary, Paul Mentzer, Sr., 7242 Bingham Street, Philadelphia 11, Pa.

PITTSBURGH meets third Thursday of each month at 6:30 P. M., at the Keystone Hotel, Pittsburgh, Pa. Secretary-Treasurer, R. A. Dimon, 210 Semple Street, Pittsburgh 13, Pa.

PROVIDENCE-ATTLEBORO meets the third Monday of each month at the Providence-Baltimore Hotel. Secretary-Treasurer, Charles C. Chace, 11 Friendly Road, Cranston 10, R. I.

ROCKFORD meets second Monday of each month at the Faust Hotel, Rockford. Secretary, E. J. Budden, 122 Twelfth Street, Rockford, Ill.

ROCHESTER meets third Friday of each month at the Hotel Seneca, Rochester, N. Y. Secretary, Robert L. Flint, 78 Durand Drive, Point Pleasant, N. Y.

SAN FRANCISCO meets the second Thursday of each month, alternating between St. Julien Cafe in San Francisco and Victor's and Roxies' Cafe in Oakland. Secretary-Treasurer, F. W. Huntington, 1621 Lafayette St., Alameda, Calif.

SPRINGFIELD meets the fourth Monday of each month at the Hotel Charles. Secretary-Treasurer, Paul Lyman, Millers Falls Company, Greenfield, Mass.

ST JOSEPH VALLEY. Secretary, Raymond A. Friend, 1435 Howard Street, Niles, Mich.

ST. LOUIS meets second Wednesday of each month at the York Hotel, 6th and

BRANCH DIRECTORY

(*Continued from preceding page*)

Market Sts. Secretary-Treasurer, E. R. Hunleth, 4415 Michigan Avenue, St. Louis, Mo.

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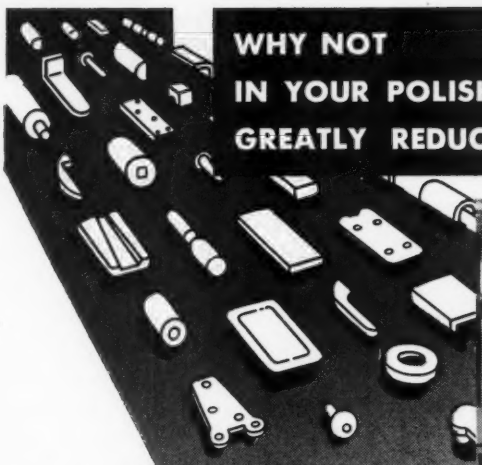

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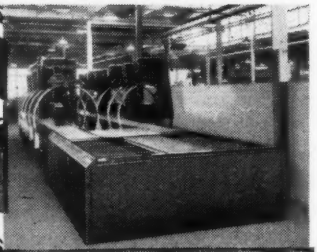

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Whether you are polishing auto door handles, watch cases, toaster bodies, or something else a Udylite Polishing Machine with one operator will give you more production in less floor space than a number of lathes each with its own operator.

Not only that but each piece will be polished evenly over all surfaces and every piece will look like every other piece because they are all presented to the wheels in the same manner.

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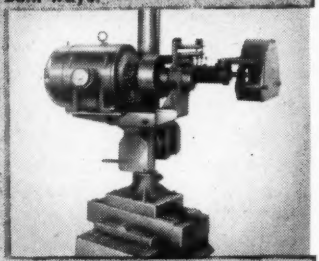

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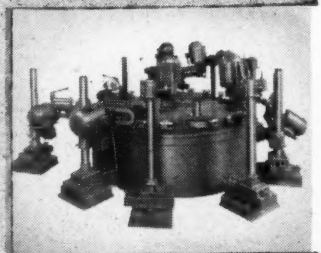

Udylite Rotary Polishing Machine equipped with indexing mechanism.

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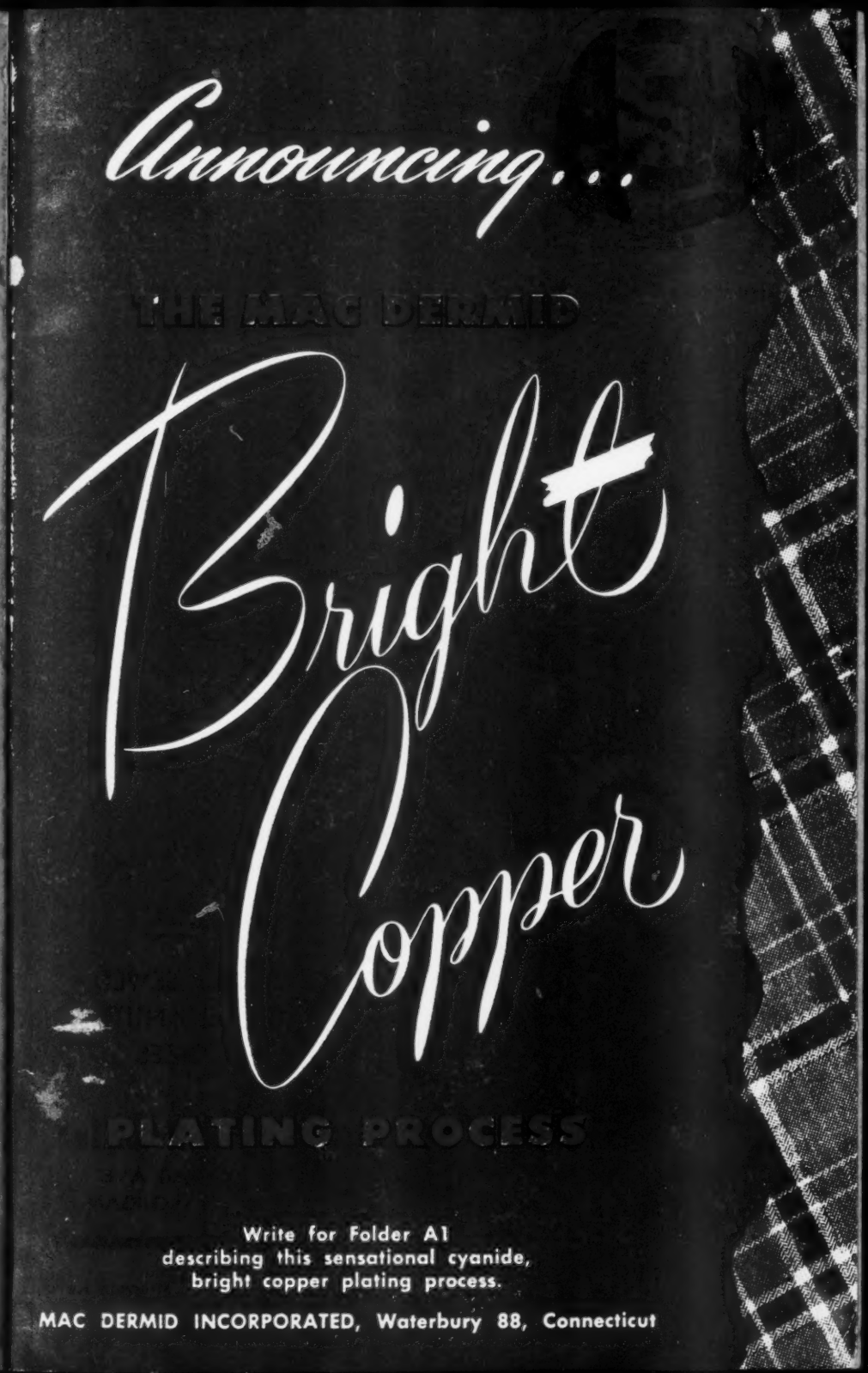
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